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WASTELANDS DEVELOPMENT—A CASE FOR *PROSCPIS JULIFLORA*

D.P.S. VERMA*

Wasteland is defined as that land which is presently lying unutilised due to certain constraints. It comprises of cultivable land and uncultivable land. Dr. Sekhar of Ford Foundation considers any land producing less than 20% of it's potential as wasteland. According to the National Wastelands Development Board "any land if it's productivity is lesst han what it ought to be with reference to the availability of soil nutrients and water should be considered as wastelands". Going by the latter definition, most of the Indian land mass will fall under the category of wasteland; land wasted by human race through its various acts of ommission and commission. Disforestation in the most part and excessive use of water in some, have rendered large tracts of country's land unproductive to a stage that retrieval seems an uphill task if not impossible.

The "Hand-book on Agriculture 1980" recognises following land uses in India :

Land uses	Area under various land uses (m ha)	% of total area
Net area sown	143	43.47
Area under forests	67	20.36
Under non-agriculture use	18	5.47
Pastures and groves	16	4.86
Cultivable waste	17	5.17
Fallow land	22	6.69
Barren and uncultivable waste	22	6.69
Area for which no return exists	24	7.29
Total :	329	100.00

Earlier five year plans laid an undue emphasis on extension of land under agriculture and a fairly large chunk of good forest was lost under the grow more food campaign. The situation worsened in hilly terrain where luxuriant forests were cut and land went under submergence for Hydro-electric-cum-Irrigation Projects. Large forest area was also utilised for re-settlement

* Conservator of Forests (Planning), Community Forestry Project. Gujarat State, Vadodara.

of the project affected villagers. The State of Gujarat, having only 10% (1.96 m ha) land area under forest, lost over 57,000 ha during the period 1960-1980. It is true that due to increase in irrigation potential and intensive agriculture, today, we are not only self sufficient in food production but are in a position to export large quantities of Wheat and Soyabean. On the other hand, we are very much short of firewood and other forest products. Today stage is reached where we have enough of food but not adequate firewood to cook the food with. Time has come when some rethinking is necessary regarding extension of agriculture on unremunerative or less productive agricultural lands. All such lands must be diverted to tree cropping. It may be necessary to redefine the frontiers of land use, according to its capability. The best land use is said to be one under which the land produces the most and deteriorates the least. The land capability should mean not only the present capability of land to produce, but also to retain the potentiality under a given land use in perpetuity. The land must be used according to it's capability and treated according to it's needs.

During the past one decade or so, the area under agriculture has remained nearly static an indication of non-availability of more arable land. This fact, seen in the context of ever rising human and cattle population, throws some light on the condition of remaining land which is obviously so bad that it cannot be economically brought under the plough. The factors responsible for degradation are many-infertility, salinity water logging, erosion, etc. This also indicates that, by and large, areas left unutilized are either highly refractory or they have been subjected to incessant blows of mismanagement and turned into saline, eroded or barren lands, The pasture and grazing lands, which constitute about 5% of the total land area; are the most degraded They are maintained in that State with the ever increasing biotic pressures. Every twig jutting out it's head during rainy season is either ripped or trampled by the cattle, or is cut away by the people to heat their hearths. The pasture lands wear a naked, neglected and weary look, year after year.

The "Wastelands Development" a document circulated in early 1986 by the National Wastelands Development Board (N.W D B.) concedes that around 175 m ha is degraded land of various descriptions; 40 m ha in agriculture; 30 m ha in forestry and over 100 m ha of pasture and grazing lands, the hot desert of degradation, the wind and water eroded wastelands are approximately 13 m ha and 73 5 m ha respectively. Wastelands due to salinity and alkalinity account for over 7.0 m ha. Although, the records show about 77 m ha as cultivable waste, fallow land, barren land, pastures and groves, it is difficult to presume that all or even a major part of this land would be available for tree planting activity. A good deal is under encroachment by vested interests enjoying some degree of political and administrative immunity in one form or the other. A fair proportion is practically uncultivable.

Wastelands suffer from one or more of the following infirmities :

1. Steepness of terrain, by and large natural;

2. Low soil depth and/or stony structure;
3. Poor in humus and nutrients;
4. Salinity and/or alkalinity;
5. Low and/or badly distributed rainfall, leading to poor moisture status;
6. Too low or too high temperatures, making cold or hot deserts;
7. Fast wind causing severe erosion;
8. Too much water coupled with poor drainage, leading to water logging;
9. Heavy biotic pressure;
10. Local customs such as shifting cultivation, followed by brush wood burning, etc, and
11. Abuses due to illiteracy, notions, greed, etc.

The above list precludes such less, limiting and local factors as frost hailstorm, salt laden winds, fires, etc. Many of the factors are bound to reduce the fertility of land specially when less than 2% of world's forest area has to meet the needs of nearly 15% of it's population. This is compounded by the rising standard of living of the masses, irregular distribution of forests and low productivity (0.53 m^3 per ha of our forests against the world average of over 2.1 m^3 per ha). Further, we have lost about 7% of our forest area in a comparatively short span of 3 decades. On the other hand, over 77 m ha (175 m ha according to N.W. D.B.) is wastelands. Add to this the factor of acute poverty, quite a large population of the country is either unemployed or it is under-employed.

Thus, while on one hand, scarce land resource is lying unutilized, on the other hand millions of poor people of the country go without bread due to non-availability of opportunities for employment. We have resource to use and develop and also the unemployed man-power to work on this resource. It is due to this reason that every sensible man in the country is talking to wed these two massive resources for over all improvemeat of the country. It was under these circumstances that our dear Prime Minister in his broadcast to the nation on 5th January, 1985 gave a clarian call to undertake massive afforestation programme of planting fuel and fodder trees and develop 5 million hectares of wasteland every year in order to avert a major ecological and socio-economic crises which is looming large on our heads and likely to attain an ugly proportion of a national catastrophy. The Prime Minister's call has taken the nation by storm and no wonder, the country is gripped with the fever of finding ways and means to fulfil the challenge thrown by the Prime Minister.

Several issues are involved in carrying out this gigantic task. Managerial, Financial, Social, Legal and Technological, such as, identifying the wastelands, motivating and involving people on a massive scale, involving N.G.Os., finding financial resources for the programme, selecting proper species and developing methodology of operations are some of the basic issues involved in the programme. The latter two are the tools to be handled by technology. The Prime Minister himself has indicated the broad parameters for choice of species in as much as that species to be selected should be in a position to provide fuel and

fodder to the Indian masses. Though, broad out lines for choice of species have been laid down, their final selection has to be done by experts, depending upon the site conditions, climatic limitations and above all the need of the people. Within the broad framework of policy, it is the site which would decide the choice of species. Fortunately for us, we have a very broad spectrum of multipurpose tree species available in the country to choose from. *Prosopis juliflora* fulfils this in more respects than any other single species for most of the sites termed wasteland simply due to the reason that the areas to be tackled are, by and large, very hostile sites and there is heavy biotic pressure on them by way of cutting for fuel and grazing for cattle, goat and sheep.

Prosopis juliflora which is aptly known as Gando-baval (mad-*Acacia*) in Gujarat, is native of Central America and the West Indies. Due to it's hardiness, wide adaptability to various adverse sites, non-acceptability of it's leaves and twigs by cattle as grazing material, profuse seedling followed by heavy browzing of pods by sheep and goats thereby ensuring it's dissemination and propogation, and many other favourable characters, *Prosopis* is amongst the most widely distributed trees in the world. At present, it is spread over the continents of South America, Africa and Asia. It is either growing wild or is cultivated on large scale in northern-eastern Brazil, Peru, Sudan, several Sohelian countries, South Africa, India and Pakistan. As in India and in some other countries, it grows so profusely that it is considered a weed.

Over forty species of *Prosopis* are identified and reported so far in the world. Some of them are agressive bushes, while there are a few which produce useful forage and wood. All of them do grow under some degree of adversity of one kind or other like climatic, edaphic or biotic, *Prosopis juliflora* has proved the most agressive in our country and it is thriving more luxuriantly than many local and indegenous species Trials with various species of *Prosopis* at Bhavnagar have shown that few of them hold good promise for our country. Prominent amongst them are *Prosopis velutina* (provenance 475)—quite fast growing and drought resistant; *Prosopis alba* a fast growing trees with high content of sucrose and proteins in it's pods which are valuable as cattle feed; *Prosopis glandulosa* and *Prosopis pallida* are very agressive and fast growing in their native land but in comparison their rate of growth is rather slow at Bhavnagar though general state of health of plants is good; *Prosopis velutina* (provenance 457) can withstand very high salinity of water; *Prosopis alba* (provenance 388) is a thornless species and has shown very promising rate of growth under Bhavnagar Conditions. It's leaves and tender branches are relished by cattle unlike most of the other species of *Prosopis* genus. It is a good species for areas suffering from fodder crises.

This wonder child of nature (*Prosopis juliflora*) was introduced in India somewhere in 1876 due to the efforts of a Forest Officer Lt. Col. R.H. Beddome who was the Conservator of Forests of Northern Circle of Madras Presidency. The species was first tried at Camalapur in Cuddapoh district of present Andhra Pradesh. This delicate and shy looking plant took to India as fish takes to water, and never looked back right from

its first day of introduction and slowly established its domain over arid, sterile, saline, degraded and sandy sites. Such hostile sites, which had no suitable tree to clothe them, found a good shady tree with evergreen foliage in *Prosopis* and it soon became a darling of millions of people who live in the vicinity of such sites. *Prosopis juliflora* soon spread to such hostile sites through out the length and breadth of the country at times with the efforts of foresters and more often without any attempt whatsoever. Though, exotic, *Prosopis juliflora* has made India its home and has spread rapidly, established, got acclamatized and holds great promise for the hostile sites particularly in arid and semi-arid saline wastelands.

Prosopis juliflora can claim for itself, the first rate preference to establish itself as one of the major species for wasteland development due to the following unsurpassable qualities.

Source of Fuel

The most important use of *Prosopis juliflora* is as fuel. Its capacity to produce fuelwood over a short period specially on hostile land like wastelands is unsurpassable. It produces an excellent firewood for cooking stoves, and for heating in rural areas. The calorific value of *Prosopis* wood is well comparable with other trees grown in semi-arid areas which is clear from Table 1.

Table 1

Camparative calorific value of some of the important fuelwood species of semi-arid areas

Name of species.	Calorific value Cal /kg.
Acacia auriculiformis	4800
Acacic nilotica (sap-wood)	4800
Acacia nilotica (heart–wood)	4950
Acacia leucophloea	4886
Prosopis juliflora	4800
Acacia tortilis	4360

Apart from the calorific value the wood of *Prosopis juliflora* produces very little quantity of ash (2 9%) and yields excellent charcoal of gun powder quality – which is termed "Arthracits coal" for its high calorific value. The wood contains about 40% lignin which imparts high heat of combustion to the wood The root wood is very hard and a top class firewood with insignificant sap wood and is very much valued for household or restaurant cooking. The fuelwood burns with little smoke and is much sought after for barbecues as it imparts a delicious flavour to the meat. As recent as IInd World War, the firewood was used to power steam engines and industrial boilers in Argentina in place of coal.

An excellent producer of Biomass

Prosopis is an excellent producer of biomass. It ranks first amongst the high biomass producing native trees of arid and semi-arid areas of India. An experiment to determine biomass productivity of important native trees of semi-arid areas was undertaken by the Forest Department of Gujarat State during 1979 under rainfed conditions at Gandhinagar. In all, seven local fast growing, fuelwood species, were planted under identical field conditions and their total biomass production was determined periodically. The work of recording of data of biomass production was carried out at regular interval by Dr. Gurumurti of Plant

Table 2

Biomass production by different species at the end of 5th year

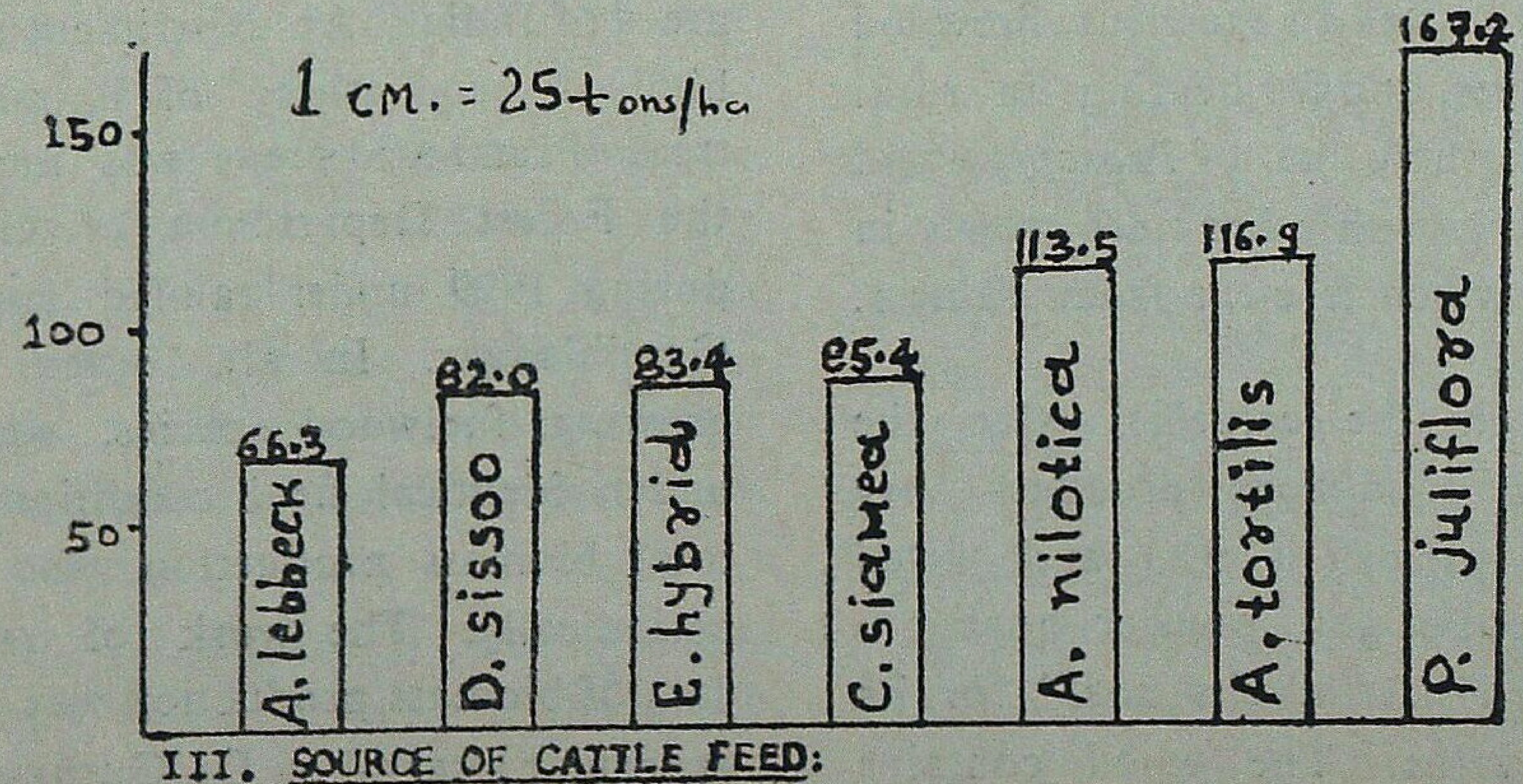
Name of species	Biomass Production in tons/ha		
	Utilizable	Non-utlizable	Total
Albizia lebbeck	59.6	6.7	66.3
Dalbergia sissoo	75.5	6 5	82.0
Eucalyptus hybrid	76.1	7.3	83.4
Cassia siamea	77.5	7.9	85.4
Acacia nilotica	110.1	3.4	113.5
Acacia tortilis	113.9	3.0	116.9
Prosopis jullflora	158.3	8.9	167.2

Physiology Branch of Forest Research Institute, Dehra Dun. The different species produced the following quantities of biomass at the end of 5th year (Table 2).

The above figures conclusively prove that *Prosopis juliflora* is miles ahead in biomass production when compared to its other associates which are normally grown in dry zone areas. This comparison is shown in a bar diagram as under.

Source of Cattle feed

The most negative single factor against *Prosopis juliflora* as a prospective species for wasteland development is its incapability to provide leaf fodder for cattle and presence of thorns which makes working with it difficult. But one thing should not be lost sight of that raising of trees is becoming more and more difficult under heavy biotic pressure of large number of cattle let loose to roam about. Though, *Prosopis* leaves do not attract animals for fodder, this is more than compensated by its pods. It is reported that the *Prosopis* pods were used as food by human beings in



III. SOURCE OF CATTLE FEED:

the new world and, even today they are source of cheap supply of carbo-hydrates and proteins for many dwellers of desert in North America. The pods are produced within a very short period so much so that tree of 2-3 years of age start producing pods and profuse production starts from 4th year onwards. Another interesting and favourable feature of pods production is that they are produced twice a year and do not split on drying like other legumes. Consequently, neither pulp nor seeds are lost. This enables the locals either to use them directly or to collect them for their use at a later convenient time. Very few other legumes can compete with *Prosopis* in this respect. This feed can be stored over long periods for use during lean months of the year at later stage without any deterioration in the quality of pods.

The pods yield sweet yellow and sticky pulp within which lie the seeds. The pulp is masocarp and its weight varies considerably but experience has shown that it makes about 40% of weight of dry pods. The pulp is mainly sucrose—a precious sugar, which makes the pod an ideal cattle feed. Livestock relish the pods and so do the sheep, goats, horses, donkeys, mules and the herbivorous amongst wildlife. The feed value of *Prosopis* pods is roughly comparable to that of barley or corn.

Another important and interesting fact about *Prosopis* pods, as cattle feed, is about the timings of their availability. The major crop of pods is produced in dry season when little alternative cheap cattle feed is available from any other source in difficult arid areas. In some of the most hostile arid areas in Hawaii, Peru, Argentina, Chile and Kachchh (Gujarat) in India, pods sustain animals particularly those belonging to poor villagers for about a month or so, of the most vulnerable period of the year.

Prosopis seeds are valuable as cattle feed from nutrition point of view also. They contain about 30 to 40% proteins and about 7-8% of oil. The only limiting factor is that to make use of these nutrients by animals, the seed or for that matter the entire pods are required to be crushed or ground or otherwise the seed, due to presence of hardcoat, would pass through digestive tract unutilized. Another constraint for use of seed is its difficulty in grinding due to presence of sticky pulp surrounding it as this makes the grinding difficult.

There used to be feeling amongst villagers that the *Prosopis juliflora* pods are toxic as cattle feed but this is not borne out by actual experience. Pods of some of the other species of *Prosopis*, like *P. pallida*, *P. glandulosis*, etc. are reported to be having toxicity in them and it affects the cattle health and causes "Jaw and tongue" trouble, loss of weight and difficulty in chewing but no such effect is reported from pods of *Prosopis juliflora* in India. Kargarrd and Van Des Maruse (1976), had reported that *Prosopis juliflora* growing in South Africa has proved to provide a fairly well balanced, highly digestive diet for sheep, without any ill effect even when they were kept exclusively on these pods for prolonged periods.

Source of Honey

Prosopis vegetation has proved as a favourable home for honey bees. Where-

ever *Prosopis* has invaded the land, its first effect has been manifold increase in production of honey in the area. Hawaii, which was not on the honey map of the world, became one of the top most honey producing country of the world after introduction of *Prosopis*. Even in India, *Prosopis* has lately been recognized as one of the major honey producing tree species. In Gujarat, about one lakh Kilogram of honey is coming out annually from *Prosopis* infected district Kachchh, with a potentiality to increase it manifold. The nectar gathered from *Prosopis* trees by honey bees is reported to be of superior quality with attractive flavour.

Timber

Prosopis is a medium sized tree with a short trunk and spreading branches. It is, therefore, capable of producing only small size timber specially when grown on hostile sites, which we are likely to come across among the wastelands. Even the small length timber is usually not straight and it has little use as lumber. The timber is crooked and more often than not, hollow but this small size timber has certain positive qualities. It has striking grain; it takes very good polish; it is long-lasting in uses involving contact with ground. Wherever small size can be used, it can replace Khair wood - the famous axle wood of India. Due to some of its qualities specially of grain and ability to take good polish, *Prosopis* timber has been equated with Walnut, Rose wood or Mahogony in certain parts of the world (Dobio, J.J. 1943, the conquering mequite, National History Museum, 51, 208-217). The *Prosopis* timber has been used in certain parts of the world for varied purposes like parquet flooring, furniture and turnery items. Blocks of *Prosopis* were used as first street paving in San Antonio, Texas, Moreover, as recent as about 30 years back, major avenues of Buenos Aires, Argentina were "cobble-stoned" with cubes of *Prosopis* wood set on sand and coated lightly with tar. The resulting road surface was smooth, noise absorbent and this surface lasted for 10-15 years (Resource for future – National Academy for Sciences Washington D.C. 1979 – Page 155). In India *Prosopis* timber has hitherto found an accepted role only as fence posts and small pilings.

Source of Nitrogen

Prosopis is a legume and like any other legume, it fixes atmospheric nitrogen – an essential element needed for growth and development of plants and in which Indian soils are acceptedly poor. This ensures growth and survival of *Prosopis* on poorest of the soils in semi-arid to arid lands that would otherwise remain economically unharnessed. This makes *Prosopis* one of the important, prospective tree species with high potentiality for wasteland development. It is also reported (Falpler and Maines, 1977) that soil beneath *Prosopis* trees can be three times richer in nitrogen than soil more distant from the plant. It is due to this reason, that forage grass is reported to be growing well in combination with *Prosopis* as the nitrogen and shade provided by *Prosopis* are often evident in the colour and vigour of grasses growing nearby.

Drought resistant species – An excellent tree for arid and semi-arid areas

Prosopis, though, it loves moisture, can grow well in low rainfall areas also. *Prosopis*, usually needs an average annual rainfall of about 500 mm (20″) but it can

establish itself quite well even in areas receiving much less and erratic rainfall. It is reported establishing itself in areas having as low annual rainfall as 3″. *Prosopis* has spreading network of lateral roots that penetrate down to 10 m depth in search of sub-soil moisture. The roots of one of the sister species of *Prosopis juliflora*, namely, *P. volutina* were recovered from an open pit copper mine at a depth of 53 m in Tucson, Arizona. Due to an excellent root system, *Prosopis* is very drought resistant and is well adapted to heat of dry regions.

The foregoing paras show that *Prosopis* is a source of food, fodder, fuel, wood, shade and shelter in warm deserts of the world like North America, and other similar parts of the world including India. In certain parts of the world, like Atacama and Gram-chaco deserts of South America, where *Prosopis* grew abundantly in nature, it was considered of great value providing timber and other products for which no other source was available. Subsequently, natural stands were logged out. *Prosopis* also easily withstands protracted droughts and can be relied on to survive and even produce a crop of pods during a drought year. In arid parts of India, thousands of villagers, particularly the less privileged and the poor, look upto *Prosopis* as their savior because it provides them fodder, shade, fuel and source of employment when everything else has vanished in years of long droughts.

Prosopis can stand well to hostile sites of wastelands. It does well even on nutrient deficient poor soils. It can grow well in barren wasteland if it has some depth and the sub-terranean water is available. It also thrives well in light sand or rocky soils. It can also tolerate salts to a great extent, and responses well to the underground saline water having salinity of 3000 to 5000 ppm Such land is otherwise useless for most of the crops in arid zones. Thus, *Prosopis juliflora* with all its qualities, is an excellent plant for problem sites in arid areas. It is an excellent species for erosion control, for stabilizing shifting desert or coastal sand dunes. It is also an excellent tree for wind breaks, shelter belts and for reforesting wasteland in arid and semi-arid areas of the country.

A coppicing tree with a very easy and rapid propagation

Prosopis can be propagated very easily by seeds, through suckers, and from root and shoot cuttings. It is an excellent coppicer. Some compare it with God – the Almighty. "More you hurt (cut/fell) it, more it gives". When livestock feed on whole pod or unground-seed, the seed passes intact and undigested through the digestive tract of the animal and gets disseminated from place to place by the wandering livestock. The undigested seed with slightly softend coat germinates profusely when lodged in the ground. This quality coupled with its capacity to withstand adverse climatic conditions and heavy grazing, has given it the stigma of aggressiveness and spreading nature.

Species undamaged by enemies of vegetation

The two main factors, which have reduced tree cover in the country, are uncontrolled grazing and uncontrolled removal of vegetation for fuel. *Prosopis* can stand upto both these enemies of vegetation and would probably defeat them in a fair war though at times, it may look losing the local battles.

Economics

A few enterprising farmers have tried *Prosopis juliflora* in commercial plantations on their problematic sites. Shri Kalidas Patel of Vatwa (Ahmedabad) raised *Prosopis juliflora* under rainfed conditions on 24 ha piece of his land in Adarsh farm of Vatwa (Ahmedabad) raised *Prosopis juliflora* under rainfed conditions on 24 ha of land which has pH value of 9.0 which receives annual rainfall of about 750 mm. Inputs like chemical fertilizers, pesticides and farmyard manure were applied periodically. The crop was harvested at the end of five years. Total expenditure during 5 years was Rs. 8300/- per ha. The returns at the end of this period per ha were – pods about 2.5 tonnes valued at Rs. 1250/- and firewood 80 tonnes valued at Rs. 24,000/-. The total returns worked out to Rs. 25,250/-. Thus, the net returns were Rs. 16,950/-. Say Rs. 17,000/ per ha for 5 years or Rs. 3390/- per ha/year.

Limitations

While on one hand, *Prosopis* is an excellent tree species for hostile sites of arid and semi-arid areas, it has certain limitations. The first and the foremost limitation is that it is essentially a tree for arid areas and hostile sites and not quite desirable for good sites with better moisture availability where other valuable trees can be grown. In such areas, there is always the fear of its ousting other valuable species and even encroaching on agricultural fields due to it's agressiveness and spreading nature. It prefers soft soils with some depth and is not happy in rocky, gravelly or pure murrumy and stoney soils. It does not provide grazing which is both in it's favour and against it.

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SUMMARY

N.W.D.B has estimated that India has about 175 m. hectares of Wastelands. Majority of these lands were, once upon a time, productive lands but human race, by its various acts of ommission and commission, has turned these lands into wastelands.

By and large, the country is self sufficient in food grain production at present We are poised for a large scale export of crops like wheat and soya-bean. The cultivated half of India is also not in a very good productive shape and unless uncultivated half is quickly brought under tree cover, the productivity of cultivated half would be endangered. Time is, therefore, ripe to have some rethinking about the extent of area to be kept under cultivation. Surplus food stocks in the country have given us an opportunity to redefine frontiers of various land uses according to it's capability. Our approach now should shift from extent to quality of land under agriculture.

The area under Agriculture has remained nearly static, inspite of tremendous pressure

of human and cattle population, which indicates that the remaining uncultivated half of India is under such physical conditions that it can not be economically brought under the plough. Thus on one hand, half of the area of the country is lying unutilised, on the other hand, there are millions of people who are either unemployed or under-employed. Government of India has, therefore, very correctly decided to bring these two massive unutilised or underutilised resources together by its massive afforestation programme initiated through N.W.D.B. While giving a clarian call for launching this massive afforestation programme, the Prime Minister has indicated the preferences for the type of trees to be planted under the programme in as much as that trees, should provide fuel and fodder to the Indian masses. Though, broad choice of species is already made for the programme but within this broad framework of policy, it is the site which is going to decide which tree should be planted.

Due to various reasons, by and large, only very refractory sites shall be available for planting and hence proper selection of species in going to play a very important role towards the success of the programme. Fortunately for us, we have a wide spectrum of trees to choose from but few trees have stronger claims over others due to their specific qualities. Though, despised by many, *Prosopis juliflora* is an excellent tree for this programme for arid and semi-arid saline wastelands. It has many unsurpassable qualities like hardiness, wide adaptability to various hostile sites, non-acceptability of its leaves and twigs by cattle as grazing material, profuse seeding followed by heavy browsing of pods by sheep and goat thereby ensuring its easy and self dissemination and propagation, providing excellent fuelwood, charcoal, honey, cattle feed, small timber, nitrogen fixing qualities, resistance to prolonged droughts, capacity of profuse coppicing and to stand to salinity and/or alkalinity etc. which are not possessed in such superabundance by any of it's associates growing in arid and semi-arid tracts of the country. Inspite of its few weaknesses like aggressiveness of weed and tendency to spread to good areas, *Prosopis juliflora* has a very strong case for its acceptability in the programme specially for arid and semi-arid wastelands.

निष्कृष्ट भूमि विकास—प्रोसोपिस जूलीफ्लोरा का दावा

डी०पी०एस० वर्मा

सारांश

राष्ट्रीय निष्कृष्ट भूमि विकास मंडल ने अनुमान लगाया है कि भारत में लगभग 1750 लाख हेक्टेयर निष्कृष्ट भूमि है। इसका अधिकांश भाग किसी समय उत्पादक भूमि था परन्तु मानवों की दौड़ने, अपनी त्रूटियों और गल्तियों से इन अच्छी जमीनों को निष्कृष्ट भूमि बना दिया है।

मोटे तौर पर, इस समय हमारा देश अन्नोत्पादन में आत्म निर्भर है। गेहूँ और सोयाबीन जैसी फसलें हम बड़े परिमाण में बाहर भी भेज सकते हैं। खेती करने वाला भारत का यह आधा भाग अधिक अच्छी उत्पादक अवस्था में नहीं है और जब तक खेती में उपयोग न किए जाने वाले आधे भाग पर वन नहीं लगा दिए जाते कृषि किए जा रहे आधे भाग में खतरा बना रहेगा। इसलिए अब उपयुक्त समय है कि फिर से सोचा जाए कि कितने क्षेत्र पर खेती की जानी चाहिए। हमारे देश में उपलब्ध अतिरिक्त अन्न भण्डार ने हमें अपने भूमि

उपयोग की सीमाएँ उनकी उपयुक्ततानुसार पुन: परिभाषित करने का अवसर प्रदान किया है। अब हमें कृष में लगी भूमि के विस्तार के बजाए उसकी गुणवत्ता बढ़ाने पर ध्यान लगाना चाहिए।

कृषि क्षेत्र मानव और पशु संख्या के भारी दबाव के बावजूद लगभग वहीं का वहीं स्थिर बना रहा है जिससे यह संकेत मिलता है कि भारत का अवशिष्ट अकृषिकृत आधा भाग ऐसी भौतिक अवस्था में है कि उस पर हल चलवा देने से कोई आर्थिक लाभ नहीं मिल सकता। अत: एक ओर तो देश के भूक्षेत्र का आधा भाग अप्रयुक्त पड़ा है दूसरी ओर करोड़ों लोग बेरोजगार या कम रोजगार पाए पड़े हैं इसलिए भारत सरकार ने ठीक ही इन दोनों अप्रयुक्त या अल्पप्रयुक्त ससाधनों को अपने विशाल बनीकरण कार्यक्रम द्वारा एक साथ करने का निर्णय किया है जो उसने राष्ट्रीय निष्कृष्ट भूमि विकाश मडल द्वारा शुरू कराया है। यह विशाल वनीकरण कार्यक्रम आरम्भ करने की घोषणा करते समय प्रधान मन्त्री जी ने यह भी समझाया है कि इस कार्यक्रम के अन्तर्गत इस तरह के पेड़ों को प्रमुखता दी जानी चाहिए कि उनसे भारतीय जनता को ईधन-चारा उपलब्ध हो। यद्यपि मोटे तौर पर इस कार्यक्रम के लिए वृक्षजातियों का चुनाव किया ही जा चुका है किन्तु इस नीति के भीतर रहते हुए भी स्थान ही इस बात का फैसला करेगा कि उस पर कौन से वृक्ष लगाए जायेंगे।

अनेक कारणों से मोटे तौर पर वृक्ष लगाने के लिए अत्यधिक अप्रतिचारी स्थल ही उपलब्ध होंगे, इसलिए कार्यक्रम की सफलता में वृक्षजातियों के उचित चुनाव की बहुत अहम भूमिका रहेगी। सौभाग्य से हमारे पास चुनाव करने के लिए बहुत सारी वृक्षजातियाँ हैं परन्तु कम ही वृक्ष जातियाँ ऐसी हैं जिनका अपने विशेष गुणों के कारण दूसरों की अपेक्षा अधिक मजबूत दावा है। बहुतों की घृणा के बावजूद प्रोसोपिस जूलीफ्लोरा शुष्क और अर्द्ध-शुष्क लवण निष्कृष्ट भूमियों में इस कार्यक्रम के अन्तर्गत लगाने के लिए अत्युत्तम वृक्ष जाति है। सहिष्णुता, अनेक प्रकार के प्रतिकूल स्थलों में बहुत अनुकूलनीयता, पत्तियों और टहनियों की ढोर-डगरों द्वारा चरने की अस्वीकृति, प्रचुरमात्रा में बीज बनना और तदुपरान्त फलियों का भेड़-बकरियों द्वारा अधिक चरा जाना जिससे इसका सरलता से स्वयं प्रसरण और प्रवर्धन हो जाता है, अत्युत्तम ईधनकाष्ठ, कोयला, शहद, पशुचारा, लघुकाष्ठ नाइट्रोजन स्थिर करने की शक्ति, लम्बे समय तक सूखा सह सकना, काटने पर बारम्बार नये तने विकसित हो जाना, लवणता और/या क्षारीयता को झेल जाना, आदि गुण इसमें हैं जितने इतनी प्रचुरता में देश के शुष्क और अर्द्ध-शुष्क भागों में हो रही इसकी किसी सहचारी वृक्ष जाति में नहीं पाए जाते। इसकी कुछ कमजोरियां रहने पर भी जैसे तृणक की आक्रामकता और अच्छे क्षेत्रों में फैल जाने की प्रवृति, प्रोसोपिस जूलीफ्लोरा का इस कार्यक्रम के लिए, विशेषकर शुष्क और अर्द्ध-शुष्क निष्कृष्ट भूमियों में लगाने के लिए, स्वीकार किए जाने का बहुत मजबूत दावा बनता है।

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STANDARDIZATION OF NURSERY TECHNIQUES (SEED SOWING METHODS AND WATERING SHEDULES) OF *EUCALYPTUS* FRI-4 UNDER NORTH INDIAN MOIST TROPICAL CLIMATIC CONDITIONS

V.K. BAHUGUNA, PYARE LAL AND V.K. DHAWAN

Directorate of Silviculture Research,
Forest Research Institute and Colleges, Dehra Dun (India)

Introduction

Eucalyptus is an Australasian genus consisting of more than 140 species, most of which are found in Australia and some in Tasmania, New Guinea and other Islands.

Many species of the large, predominantly Australian genus *Eucalyptus*, are commercially planted and Silviculturally managed in several countries for wood, pulp and timber production in short-rotation fellings. *Eucalyptus* occupy perhaps one fifth of the world's man-made forests and are likely to become the principal pulpwoods on world markets. Recently two heterotic and potentially high yielding *Eucalyptus* species hybrids FRI-4 (*Eucalyptus tereticornis* × *Eucalyptus camaldulensis*) and FRI-5 (*Eucalyptus camaldulensis* × *E. tereticornis*) were developed at Forest Research Institute, Dehra Dun. (Venkatesh and Sharma, 1977 a, 1977 b).

Eucalyptus FRI-4 displayed a striking and sustained degree of hybrid vigour in height and diameter growth and hence in volume production in an experimental field trial at Forest Research Institute, Dehra Dun at the age of four years, which corresponds to only half or one third of 12 years rotation cycle currently adopted for *Eucalyptus* grown in India, this hybrid held four times more standing volume than the parental controls and more than twice that of the Mysore gum which is today the most widely planted *Eucalyptus* in this country (Venkatesh, 1978). Further studies are going on in Genetics branch to obtain pure strains of vigorous growth.

The *Eucalyptus* are evergreen trees, all more or less aromatic and containing oil glands in the leaves; the oil distilled from the leaves of some species is of value in medicine. The flowers are white or red and the flower buds have the calyx-tube covered with a lid or operculum which falls off when the flowers open. The fruit is a woody capsule containing small seeds, seed texture is both rough or smooth. Seed colour is black with brown husk. Flowering period is from Ist week of November to second week of December and seeds ripen from March to April.

Objectives

Raising seedlings of tree species in nurseries is common phenomenon in plantation forestry world over. The massive targets of afforestation demand that optimum level of production of seedlings is determined from a given quantity of quality seeds for ensuring economic and efficient use of seeds and other resources. In this paper,

the results of an experiment laid out for determining the best combination of method of sowing, and optimum irrigation schedule and quantity of seeds for the production of healthy and plantable seedlings for afforestation purposes, are discussed.

Materials and Method

The studies were conducted at Brandis Road nursery of Silviculture Branch at New Forest Estate, Dehra Dun. The New Forest Campus is situated between 33°-20′ N latitude and 78°-3′ E longitude at an elevation of about 610 m.

The experiment was initiated on 6.2.1986 and continued upto 17.6.1986. The meteorological data on maximum, minimum and mean temperatures, relative humidity per cent, rainfall and bright sunshine during the course of this study is given in Table 1.

The details of the physical and chemical properties of the nursery soil are given in Table 2. The nursery soil samples were tested after preparation of the beds and mixing the washed river sand with sieved farmyard manure.

Preparation of beds : All beds were prepared well before the commencement of sowing the seeds. The nursery field was ploughed by tractor and allowed to weather. The size of nursery beds was 10 m × 1 m dimension, raised upto 20 cms from ground level and were provided with bamboo support, on both sides of the beds, to prevent wash out of the soil. Each bed was kept free from weeds and other foreign materials 0.12 m^3 of well decomposed sieved farmyard manure and washed river sand in equal proportion were added in each bed and thoroughly mixed with soil upto the depth of 10 cms. According to the design 36 bed were prepared

Source of seed : The seeds for this experiment were collected from the trees growing in the New Forest Estate. Seed collection was done during April, 1985 The seeds were treated with Agrosan, G N for the prevention of seed borne diseases. Initial

Table 1

Monthly average of meteorological observations

Months	Temperature (°C)			Relative humidity %		Rainfall mm		Bright Sunshine (hours) (Average)
	Max. (Av.)	Min. (Av.)	Mean (Av.)	0700 hrs (Av.)	1400 hrs (Av.)	Tatl rainfall during the month	No. of rainy days	
Feb. 1986	21.2	6.1	13.4	97	54	88.1	4	7.3
March 1986	26.1	10.2	18 0	90	46	50.7	4	8.1
April 1986	31 6	13.5	22.6	85	38	22.2	3	9.1
May 1986	32.7	16.3	23.6	79	45	66.1	7	9.6
June 1986	33.7	20.2	26.2	83	56	282.5	12	8.2

Source : Meteorological observatory, Forest Influence Branch, Forest Research Institute, New Forest, Dehra Dun.

Table 2

Physical and chemical analysis of nursery soil

Nursery soil (from prepared beds)	Water holding capacity per cent	pH	Organic carbon per cent	Total nitrogen per cent	Available nutrients per cent	
					K_2O	P_2O_5
Soil + F.Y.M. + Sand 2 : 1 : 1	46.3	8.1	1.68	0.16	.02	.01

viability of the seed was determined in laboratory and was found to be 90%.

Design : Randomised complete block design (RCBD) with four replications was adopted. The seeds were sown in 36 raised beds of size 10 m × 1 m and 20 cms from the ground level.

Treatments : There were three treatments of methods of sowing viz :

Broadcast sowing	:	T_1
Dibbling sowing	:	T_2
Line sowing	:	T_3

Three levels of irrigation viz :

Without irrigation	:	I_0
Irrigation once in a day	:	I_1
Irrigation twice in a day	:	I_2

Thus the treatments were in the following combinations :

T_1I_0	— Broadcasting	: Without irrigation
T_1I_1	— Broadcasting	: Irrigation once a day
T_1I_2	— Broadcasting	: Irrigation twice a day
T_2I_0	— Dibbling sowing	: Without irrigation
T_2I_1	— Dibbling sowing	: Irrigation once a day
T_2I_2	— Dibbling sowing	: Irrigation twice a day
T_3I_0	— Line sowing	: Without irrigation
T_3I_1	— Line sowing	: Irrigation once a day
T_3I_2	— Line sowing	: Irrigation twice a day

Seed sowing and Irrigation : Three methods of sowing were tried for this study viz. Broadcasting, dibbling and line sowing as stated above. In broadcast sowing seeds were scattered over the nursery beds, as a rule no steps were taken to cover the seeds, though a layer of mixture of fine soil and washed river sand in 2 : 1 proportion respectively, was spread over the beds to cover the seeds properly.

In line sowing, lines were prepared with the help of a stick, line to line distance was 10 cms and seed to seed distance 0.5 cm. Thus 100 lines were made in these beds where seeds were sown by the line sowing methods.

Seed quantity : Equal quantity of seed was used for all the beds in each treatment. It was determined, on the basis of practical approach for sowing 1 m × 1 m bed. In this case 15 gms of seeds per bed were sown

in 35 beds. There were 3,330 seeds in 15 gms of seed. Seed per kg for this species after counting comes to 22,22,000 seeds.

Irrigation schedule : The beds were irrigated once a day, twice a day (morning and evening) and without irrigation as per irrigation treatments. Irrigation of the seedlings in nursery beds was undertaken through fine can showering from the date of sowing of seed, till the closing of the experiment. 45 litres of water per bed was applied everyday at morning time in those beds where irrigation was prescribed once a day. The same quantity was repeated in the evening for those beds where twice a day irrigation was prescribed. On rainy days no watering was done. There was no irrigation in those beds where irrigation was not prescribed. No chemical fertilizer was applied. The nursery beds were weeded as and when considered necessary to keep the growing seedlings free from weeds.

Observations recorded : The investigations on *Eucalyptus* FRI-4 were carried out during the period from 6.2.1986 to 17.6.86. Seeds were sown on 6.2.1986. Observations on number of seeds germinated were recorded everyday in each bed by counting the number of seedlings per bed, till the completion of the germination. The germination was completed in 50 days (Seven weeks). During germination period, mortality of the seedlings was also recorded everyday and dying seedlings were immediately removed. After completion of the germination, data were collected on growth of the seedlings by measurement of height and girth of the seedlings and number of seedlings available in each bed were recorded at the completion of germination at pricking out stage for planting in polythene bags. The number of healthy plantable seedlings at the close of the experiment were recorded. When the seedling attained height growth of about, 30 cm, it was considered to be plantable. Before the close of the experiment, twenty seedlings were selected and uprooted at random from every bed, for recording height and collar diameter of shoot and root length.

Results and Discussion

The observation recorded gives following results :

Statistical analysis : Statistical analysis was carried out to see whether any significant differences exist on the effect of treatments, on different characters of each species separately, for the characters such as total germination per cent, plant percent and mortality per cent. Firstly, the data has been converted to angular values (Sin^{-1} p) and then analysed. Statistical results show that except in a few cases treatments differ significantly in their effects on the various characters. The results are significant at 0.1% level of probability. The results obtained are given in the Table 5 attached. The treatments under the same bar do not differ significantly among themselves and are in the same group, while the treatments under one bar differ significantly from the treatments under different bar.

1. *Commencement of germination :* The data obtained were scruitinized to find out the effect of different sowing methods viz. Broadcasting, dibbling and line sowing and optimum irrigation schedule on the number of days required for commencement of germination. The data on commencement of germination are presented in Table 5.

The results reveal that irrigated and unirrigated beds differ significantly in terms of mean number of days for commencement of germination. It's value varies from 8.0 (T_3I_2, T_1I_2, T_1I_1) to 10.5 in T_2I_0. Thus, in case of broadcast sowing with twice-a-day irrigation (T_1I_2), once-a-day irrigation (T_1I_1) and Line sowing with twice-a-day irrigation, germination, commences fastest.

2. *Emergence energy value* : The emerging seedlings were counted daily for five weeks. A seedling was considered emerged when its cotyledons were free above the surface of soil. After 50 days at the end of the germination, total germination per cent and emergence energy were calculated. Emergence energy is the highest value obtained when the per cent of seedlings emerged on a day is divided by the number of days since the test began. The data so obtained in present in Table 3.

The data presented in Table 3 shows that combination of T_1I_2 (Broadcast sowing with twice-a-day irrigation) gives highest value (6.55), followed by T_1I_1 (Broadcast sowing with once a day irrigation) 5.55 for emergence energy value. The lower emergence energy value is recorded in the treatment T_2I_0 (Dibbling without irrigation) 0.47 followed by T_1I_0 (0.83) and $T_3 I_0$ (1.00), Broadcasting and line sowing without irrigation respectively. The results indicate that broadcast method of sowing is suitable for rasing *Eucalyptus* FRI-4 seedlings at nursery stage.

3. *Bartellet's index of germination rate :* To get an idea as to how the germination progressed with time under various treatments, total germination per cent (Cumulative) was calculated at the end of each week upto seven weeks. Germination rate index was then worked out by taking means of five weekly values of germination per cent. The data for the index of germination rate is shown in Table 4.

Table 3

Effect of different sowing methods and various irrigation schedule on the emergence energy of Eucalyptus FRI-4 seeds.

Treatments	Replications				Emergence energy value (mean value)
	I	II	III	IV	
T_1I_0	0.79	0.71	1.02	0.78	0.83
T_1I_1	4.78	4.83	5.46	5.14	5.55
T_1I_2	4.82	7.69	6.51	7.17	6.55
T_2I_0	0.48	0.51	0.34	0.54	0.47
T_2I_1	4.35	3.04	1.80	0.79	2.50
T_2I_2	4.00	2.27	2.74	1.92	2.73
T_3I_0	1.05	1.20	1.07	0.50	1.00
T_3I_1	4.28	5.22	7.65	4.11	5.32
T_3I_2	3.18	4.69	9.17	6.48	1.62

Table 4

Effect of different sowing methods and different irrigation schedule on Bartellet's index of germination rate of Eucalyptus FRI-4 seeds

Treatments	Bartellet's index of germination rate				Mean values
	I	II	III	IV	
T_1I_0	11.19	9.25	18.42	13.92	13.20
T_1I_1	65.63	52.88	60.68	52.71	57.98
T_1I_2	62.88	61.63	64.82	74.37	65.93
T_2I_0	8.82	9.38	6.13	9.65	8.50
T_2I_1	37.40	42.47	29.78	19.11	32.21
T_2I_2	40.47	32.97	31.24	35.16	34.96
T_3I_0	15.18	17.52	18.33	9.90	15.23
T_3I_1	48.60	54.78	65.80	40.73	52.48
T_3I_2	36.90	52.57	73.44	51.76	53.67

After analysis of the data presented in Table 4, it can again be concluded that Broadcast sowing with twice-a-day irrigation gives highest value of germination on Bartellet's index of germination rate which comes to 65.93 and is quite high as compared to the next value i.e. 57.98 and 53.67 for T_1I_1 (Broadcast sowing with once-a-day irrigation) and T_3I_2 (Line sowing with twice a day irrigation) respectively. The lowest germination rate is observed in the treatment T_2I_0 (Dibbling sowing without irrigation) 8.50 followed by T_1I_0 (Broadcast sowing without irrigation) and T_3I_0 (Line sowing without irrigation) i.e. 13.20 and 15.23 respectively.

4. *Czabator's index of germination value*: The germination value of *Eucalyptus* FRI-4 seed was calculated as per the method prescribed by Czabator (1962). Germination value is a product of peak value (PV) of germination and mean daily germination (M.D.G) i.e.

$$G.V. = PV \times MDG.$$

Mean daily germination was calculated by dividing the total germination per cent at the end of the test by the number of the days since the test began. For calculating the peak value, the cumulative germination per cent for each successive day was tabulated upto 150 days. Then working back from the end of the test period, successively earlier cumulative germination per cent were divided by the corresponding number of days. The successive quotients so obtained continued to increase untill the peak value is reached, which was noted. Germination value was then calculated by multiplying the peak value with mean daily germination The abstract of the data is presented in Table 5. In terms of germination value, the results in Table 5 indicate that the combination of T_1I_2 (Broadcast

Table 5

Tables giving the mean or percentage values under each treatment their significancs and necessary bar-diagrams

Characters	Significance		Bar-diagram								
Mean number of days for commencement of germination.	***	mean	T_2I_0	T_3I_0	T_1I_0	T_2I_1	T_2I_2	T_3I_1	T_1I_1	T_1I_2	T_3I_2
			10.5	10.3	9 8	8.8	8.3	8 3	8 0	8.0	8.0
Germination value	***	mean	T_1I_2	T_3I_2	T_1I_1	T_3I_1	T_2I_2	T_2I_1	T_3I_0	T_1I_0	T_2I_0
			10.17	7.86	7.66	6.87	2.42	2.42	0.42	0.30	0.10
Total Germination per cent	***	mean % value	T_1I_2	T_1I_1	T_3I_2	T_3I_1	T_2I_1	T_2I_2	T_3I_0	T_1I_0	T_2I_0
			77 06	66.95	62.01	60.54	44.72	43.27	21.29	17.52	11.09
Number of seedlings obtained	***	mean	T_1I_2	T_1I_1	T_3I_2	T_3I_1	T_2I_1	T_2I_2	T_3I_0	T_1I_0	T_2I_0
			2539	2184	2032	1962	1420	1410	483	467	269
Plant per cent	***	mean % value	T_1I_2	T_1I_1	T_3I_2	T_3I_1	T_2I_1	T_2I_2	T_3I_0	T_1I_0	T_2I_0
			76.16	65.53	60.95	58.87	42.60	42.31	14 48	14.00	8.07
Mortality per cent	***	mean % value	T_3I_0	T_1I_0	T_2I_0	T_2I_1	T_3I_1	T_1I_1	T_3I_2	T_2I_2	T_1I_2
			6.82	3.53	3.02	2.12	1.67	1.42	1.07	0.96	0 90
Shoot length (cms)	N S.	mean	T_2I_2	T_1I_1	T_3I_1	T_3I_2	T_2I_1	T_3I_0	T_1I_2	T_2I_0	T_1I_0
			82.47	82.32	79.95	78.79	77.02	74.95	74.32	66.43	64.98
Shoot diameter (cms)	N.S.	mean	T_2I_0	T_2I_2	T_3I_0	T_1I_2	T_3I_1	T_1I_1	T_2I_1	T_1I_0	T_3I_2
			.503	.480	.478	.475	.470	.458	.450	.433	.430
Number of branches	N S.	mean	T_3I_0	T_2I_0	T_1I_0	T_3I_1	T_1I_2	T_2I_1	T_2I_2	T_3I_2	T_1I_1
			8 5	7.5	7.3	5.8	5.5	5.5	5.5	5.5	5.3
Root length (cms)	N.S.	mean	T_2I_1	T_2I_2	T_1I_1	T_3I_2	T_3I_0	T_1I_2	T_2I_0	T_1I_0	T_3I_1
			37.00	35.47	35.22	34.61	33.82	31.93	30.52	29 83	27.00

*** – Indicate significant at 0.1% level of probability.

N.S.— Indicate not significant even at 5% level.

sowing with twice-a-day irrigation) give highest value (10.17), followed by T_3I_2 (Line sowing with twice-a-day irrigation) 7.86. The combination of T_1I_2, T_3I_2, T_1I_1 and T_3I_1 are under same bar diagram. The results indicate that dibbling method is not suitable for *Eucalyptus* raising at nursery stage, as even at twice-a-day irrigation it gave very poor (2.42) germination value. The reason probably is that the small seed of *Eucalyptus* during dibbling is buried in the soil and, hence poor germination. Dibbling method is more suitable for those species, which produce bigger size seeds such as *Albizia* sp. This has been proved in another experiment carried out by the authors. The lowest germination value is shown by T_2I_0 (0.10) followed by T_1I_0 (0.30).

5. *Total germination :* Data on total germination per cent were recorded daily for seven weeks from the data of commencement of germination. A cumulative germination of seeds were recorded daily and total germination per cent was calculated and are presented in bar diagram shown in Table 5.

The data in Table 5 reveals that Broadcast sowing with irrigation is the best method for this species. The treatment T_1I_2 and T_1I_1 are under same bar diagram. T_1I_2 gave highest mean per cent value 77.06, whereas T_1I_1 gave 66.95. Line sowing with irrigation gave second best germination and the values for T_3I_2 and T_3I_1 are 62.01 and 60.54 respectively. Dibbling method with once-a-day irrigation gave 44.27 and is in the same bar. Poorest germination is shown by T_2I_0 (11.09).

6. *Plant per cent :* There were casualties after germination. Many seedling in some of the beds died due to damage by insects or wild animals such as Monkeys. A record of mortality of the seedlings was maintained daily under different treatments. The number of seedlings actually obtained at the end of completion of germination was counted and plant per cent was calculated on the basis of 3,330 seeds originally sown per bed. The data are presented in Table 5.

The mean values are highest for T_1I_2 (76.16) followed by T_1I_1 (65.53), T_3I_2 (60.95) and T_3I_1 (68.87). Both the irrigation combinations of Dibbling method are under same bar and exhibit 42.60 (T_2I_1) and 42.31 (T_2I_2) plant per cent. Plant percent is poor in all the beds, where irrigation was not provided. The lowest value being exhibited by T_2I_0 (8.07).

7. *Number of seedlings obtained* : Number of seedling obtained per bed (naked rooted) with vigorous healthy growth at the close of the experiment were recorded under different treatments and are shown in Table 5. A seedling was considered healthy and plantable, when it attained the height of 30 cm.

The highest number of plantable plants were produced in the combination T_1I_2 i.e. 2539 seedlings, followed by T_1I_1, (2184) and T_3I_2 (2032). All these combinations are under the same bar diagram. T_3I_1 and T_2I_1 are under one bar and total number of seedlings produced are 1962 in case of T_3I_1 and 1420 in case of T_2I_1. Lowest number of seedlings were obtained in T_2I_0 (269), followed by T_1I_0 (467) and T_3I_0 (483). All these are under one bar. The results lead to the conclusions that though irrigation is essential at the nursery stages in *Eucalyptus* FRI-4, what is more important

is the method of sowing. Highly significant results were shown by broadcast sowing with once-a-day irrigation T_1I_1 where 2184 plantable plants were produced, as compared to line sowing and dibbling with once-a-day irrigation where 1962 and 1920 seedlings were obtained respectively.

Recommendations

On the basis of above discussion it can be concluded that T_1I_2 (Broadcasting with twice-a-day irrigation) combination gave consistently good results and higher germination value, total germination value, total germination per cent, plant per cent and maximum number of plantable plants, as compared to other combinations. This was followed by T_1I_1, i.e. same method of sowing, broadcasting with once-a-day irrigation. The results are very clear and highly significant at 0.1% levels of probability, therefore it is recommended that for raising *Eucalyptus* FRI-4 seedling at the nursery stages, broadcast sowing should be adopted with twice-a-day irrigation. Since once-a-day irrigation also gave good results in the same method of sowing, it can be recommended that initially two levels of irrigation per day may be prescribed and after completion of germination, once-a-day irrigation may be considered sufficient. The results also indicate that method of sowing is very important in *Eucalyptus*, as even irrigated beds in dibbling gave very poor results.

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SUMMARY

The paper presents the results of an investigation carried out at the Brandis Road Nursery of Silviculture Branch, Forest Research Institute and Colleges, Dehra Dun for standardization of best combination of methods of sowing and optimum irrigation schedule for the production of maximum healthy seedlings of *Eucalyptus* FRI-4. On the analysis of data, collected during the course of experiment, the quantity of seed required for raising plantation of this species in the field is also calculated. Similarly requirement of seed at the nursery stage is also determined. The results of this experiment indicate that broadcast method of sowing with twice-a-day irrigation proves to be the best combination.

उत्तर भारतीय आर्द्र उष्ण जलवायु दशाओं में युकेलिप्टस एफआरआई-4 की रोपणी प्रविधियों (बीज बोने की रीति और पानी देने की तालिका) का प्रतिमानीकरण

वी०के० बहुगुणा, प्यारे लाल व वी०के धवन

सारांश

इस अभिपत्र में उस अन्वेषण के परिणाम बताए गए हैं जो वन संवर्धन शाखा, वन अनुसंधान संस्थान एवं महाविद्यालय देहरादून का ब्रांडिस मार्ग रोपणी में युकेलिप्टस एफआरआई-4 के अधिकतम स्वस्थ पौधे उगाने को बोने की सर्वोत्तम रीति और इष्टतम सिंचाई तालिका का सर्वोत्तम संयोग प्रतिमानित करने के लिए किया

गया । संपरीक्षण के दौरान एकत्र किए गए आंकड़ों के विश्लेषण से इस वृक्ष जाति का क्षेत्र में रोपवन लगाने के लिए बीजों की आवश्यक मात्रा भी आकलित की गई । इसी प्रकार, रोपणी अवस्था में अपेक्षित बीज मात्रा भी विनिश्चित की गई । इस संपरीक्षण के परिणाम बताते हैं कि बीजों की छिटक बुआई और दिन में दो बार सिंचाई सर्वोत्तम संयोग रहेगा ।

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A STUDY ON DETERIORATION OF BAMBOOS IN RESERVE FOREST DAMTAL AND THE ROLE OF BAMBOOS IN SOCIAL FORESTRY

S.B. ISLAM* AND H S. KANWAR**

Introduction

Bamboos occur as an under-story in many types of forest in India and is found almost in all the States. It normally occupies a zone of elevation ranging from 300 to 800 meters. In Chinese culture, Bamboo symbolises 'Serenity and Sophistication' (Chinese Poet Pou-Sou-Tung), in Vietnam a brother and in India 'Green Gold' because of the large diversified uses. It meets 29.35% of the total pulpwood requirement of paper and pulp industries in the country beside various domestic uses. Bamboo forests are valuable forests in Himachal Pradesh and generally occur in Kangra, Una, Bilaspur and Sirmaur districts. In low altitude areas they were commercially exploited in the past. The bamboo forests in this State have been classified by Champion and Seth as 'Group-6 Dry Tropical Evergreen Forests'. Damtal Reserve Forest (210.(0 ha) is one major bamboo forest of Himachal Pradesh and is situated in Nurpur Forest Division. It is mainly stocked with *Dendrocalamus strictus* and scattered growth of *D. hamiltonii* and *B. arundinacea*. The bamboos of Nurpur have been classified as 'E. 9 Dry Bamboo Brakes'.

The scientific management in this division started only in 1903-04 under 'Hart's Working Plan (1903-04 to 1920-21) where annual cuttings were prescribed Walter's Revised Working Plan (1920-21 to 1930-31) prescribed biennial cuttings, preceded where necessary by careful cleanings. These biennial cuttings continue till the latest Working Plan (Nanak Chand's from 1975-76 to 1990-91) in which three year felling cycle was prescribed. This bamboo forests were worked as per prescription till 1955-56, improving the condition of forest to a great extent. In 1955-56, this forest was leased out for a period of 15 years to M/s Gopal Paper Mills, Yamunanagar, who indiscriminately felled bamboos violating prescribed rules and regulations and no cleaning too was done. Further three year felling cycle was too short and proved disastrous as a result this bamboo forest has deteriorated considerably and at present the clumps are congested and chocked with dead, diseased and dry culms.

Three compartments of North Damtal Reserve mainly C2, C9 and C19 were randomly selected and studied for the effect of above mentioned factors, such as irregular and heavy fellings and cleanings etc. on the quality of the bamboo forest. The study of this Reserve Forest has been compared with private bamboos (*D. strictus*) in Tika Duhg which was better managed.

* Divisional Forest Officer, Nurpur Forest Division, Nurpur (Himachal Pradesh)
** Asstt. Conservator of Forests, Nurpur Division.

These private bamboo forests acted as a control. Further, the role of *D. strictus* in Social Forestry Project in Himachal Pradesh has also been highlighted. The data are very valuable for the future and present management practices of bamboo forests in the State.

Material and Methods

The climate of Damtal is sub-tropical characterised by rainfall from July to September which is about 1400 mm annually. The minimum temp. varies from 2.7°C in January to a maximum of 39.1°C in May. The studies were conducted in three compartments of Damtal Reserve, namely, C2, C9 and C19. In the first compartment, R. 12. N. Damtal C2 (14-16 ha) elevation varies from 280 to 340 meters, 433.10 meters to 494.10 meters in C9 (8.90 ha) and 355.50 meters to 396.50 meters in C19 (10.93 ha). The aspect is north-eastern and south-western in C2, north-eastern in C9 and southern in C19. The slope is gentle to moderate in all three compartments, rock is of conglomerate and the soil is sandy loam mixed with gravel and boulders. In C2 the bamboo patches are confined to southern and north-eastern side, C9 is a pure bamboo forest and in C19 bamboo confined to the eastern side. Thus the locality factors of all the three compartments are almost the same. Further as mentioned for comparison the bamboos were also studied in private area of Tika Duhg which acted as control. The locality factors of the Govt. Reserve Forest and the Private area are almost the same.

For conducting the study, experimental plots of 30 × 30 m were laid at random throughout the forest compartments and in private area. The plots were so designed so as to study atleast 15% clumps in the comparment. Inside the experimental plots, all the bamboo clumps and all the culms in a clump were studied and the measurements taken and the following observations were noted clump-wise and their average was drawn for coming to a conclusion :

No. of shoots in a clump.

No. of diseased, dead and dry shoots in a clump.

No. of bent shoots with bushy appearance in a clump.

No. of first year shoots in a clump.

No. of second year shoots in a clump.

Average height of the clumps (in meters).

Distribution of shoots according to girth class (below 7.5 cm, 7.5 to 15 cm, 17.5 cm to 20 cm).

Average length of the internodes (cm).

Six plots were laid in comptt. C2 and five plots each were laid in C9, C19 and private area Duhg. The measurements were recorded in 83 clumps (3797 culms) in C2, 70 clumps (1378 culms) in C9, 69 clumps (1643 culms) in C19 and 60 clumps (3660 culms) in private area. The field observations were recorded from the month of June, 1986 to October, 1986. The spacing between the clumps in reserve as well as private area is about 7 meters. After recording the measurements of the culms in a clump, the averages were drawn for the experimental plot and later on for the compartment as a wohle. The percentages were calculated. Girth of the shoot was measured towards the thicker end on the

second internode at a distance of 5 cms above the node.

Observations

The data collected from this experiment presents very interesting observations which are of great value for the bamboo management not only in Himachal Pradesh but for the whole country. Data clearly shows that the percentage of diseased, dead and dry shoots is quite high in Reserve Damtal as compared to bamboo shoots in private area in Duhg (Table 1). Similar is the case of percentage of bushy and bent shoots in the clumps.

The healthy shoots is 86% in C2, 73% in C9 and 79% in C19 against 95% in the private area. Further, there is a marked difference in the girth of shoots in the clumps of private area bamboos and those in the reserve forest (Table 2), 12% of the shoots in the private area are under girth class 17.5 cm. to 20 cm. against the 5% in C2, 8% in C9 and 0% in C19. Also 5% shoots in the private area are under girth class 33.5 cm to 45 cm against zero% in Govt. Reserve Forest. Beyond 45 cm girth no shoot were present. Thus the shoots in private area of good girth as compared to the shoots in reserve forest.

Table 1

Effect of over fellings and lack of cultural operation on the condition of culms

Name of Comptt.	Area in ha	No. of culms counted	Culms diseased dead & dry (%)	Culms bushy and bent (%)	Total (%)	Healthy culms in Compact (%)
R. 12. Damtal C2	14.16	3797	7	7	14	86
-do- C9	8.90	1378	12	15	27	73
-do- C19	10.93	1643	8	13	21	79
Tika Duhg	3.00	3660	3	2	5	95

Table 2

Effect of over felling and cultural operation on the girth of shoots

Name of Comptt.	Shoots below 7.5 cm girth (%)	Shoots 7.5 cm to 15 cm (%)	Shoots 17.5 cm. to 30 cm. (%)	Shoots 32.5 cm to 45 cm (%)
C2	11	84	5	0
C9	47	45	8	0
C19	24	76	0	0
Tika Duhg	13	70	12	5

The number of shoots (culms) in a clump was also determined and it was found that average number of shoot in the clump is 61.00 in the private area against 48.30 in C2, 19.99 in C9 and 23.66 in C19, clearly indicating that average number of shoots in clump in reserve forest is less than the private area (Table 3). Moreover, the average height of the clumps in reserve forest was significantly low as compared to the private area. The clumps in private area are tall and stout while these in reserve forest are dwarf and weak. It is also important to note that average length of internode of shoot in the private area bamboo is 29.00 against 22.5 cm in C2, 21.0 cm in C9 and 19.48 cm in C19. Further, the girth of clump also varies and is highest in private area as compared to the reserve forest clumps.

The effect of heavy and irregular fellings and lack of cultural operations on production of new shoots has been shown in Table 4. New shoot production in private area is maximum and is of the order of 17% of the total shoots present while same figure for C2 is 10%, 13% for C9 and 14% for C19. Consequently, there are more mature shoots in reserve forest and less young shoots in contrast to the private area.

It was also observed that the bamboo *Dendrocalamus strictus* is the most commonly used bamboo for the rural areas of the Nurpur Forest Division.

Result and Discussion

Under Hart's Working Plan (1903-04 to 1920) for Kangra district a separate bamboo working circle was constituted and annual cuttings were prescribed in Reserve Damtal. Than the cleaning was not prescribed but with increases in demand after Great War (1914-18) clump cleanings was carried out during the last five year of the plan with satisfactory results. Further, biennial fellings preceded and where necessary by careful cleanings, as prescribed in Walter's Revised Working plan (1920-21 to 1930-31) for the Reserve Damtnl. Cleanings, preceded the main fellings and were instrumental in the improvement of the growing stock. The bamboos were also worked on a two year felling cycle under selection fellings and the thinnings preceded, where necessary by cleanings from 1931-32

Table 3

Effect of felling, cleaning etc. on the number of shoots, height of clump and length of internode

Name of Comptt.	No. of culm counted	No. of clumps counted	No. of clumps per clump	Average height of the clump (m)	Average length of internode (cm)
C2	3797	83	48 30	7.22	22 5
C9	1378	70	19.99	4.76	21.0
C19	1643	69	23 66	4.88	19.48
Tika Duhg	3660	60	61.00	10.43	29 00

Table 4

Effect on new shoot production (shoot production)

Name of Comptt.	Percentage Ist year new shoot	Percentage 2nd year new shoot	Percentage mature shoots
C2	10	13	77
C9	13	15	78
C19	12	13	75
Tika Duhg	17	20	63

to 1951-52 under Mohan's Working Plan resulting in further marked improvement of the Reserve Damtal. From 1951-52 to 1975-76, the same prescription was followed under Ramesh Chandra's Working Plan. The theoretical rotation was six year. All bamboos were worked satisfactorily and only according to working plan prescription till 1955-56.

Subsequent of 1955-56, the bamboos of Reserve Damtal were leased out for period of 15 years to M/s. Gopal Paper Mills. Yamunanagar for a lump-sum royalty of Rs 5000/-annum.

During 1955-56 to 1971-72, the bamboo forests had been exploited more with an eye on immediate return rather than their development by way of nursing of the present crop M/s. Gopal Paper Mill indulged in reckless fellings without paying any attention to the agreement and prescribed rules for selection fellings and thinnings as well as cleanings. In fact, the lessees worked in a selective manner removing the healthy and vigorously growing bamboos leaving behind struggling small and malformed clumps. Tending of the clumps has not been given due attention. Even new shoots were cut in some places and cleaning was not done. The two year felling cycle was too short and proved disastrous. Due to these factors, the clumps are congested, dead and dry culms are present in the clumps, new shoot production is effected and these bamboo forests have deteriorated considerably.

In contrast to the deplorable condition of bamboos in Reserve Damtal, the bamboo clumps in private area, Duhg are in much better condition and are healthy. The bamboo owners regularly clean the clump and remove the dead, dying and malformed etc. shoots and nurse the crop. Further, since the private sale of bamboos is allowed in Himachal Pradesh under three year felling cycle, owners sell bamboos to the contractors, as the cost of Rs. 10/-culm. The fellings of private bamboos by the contractors is purely according to felling rules and regulations and private bamboo owners make it sure that there is no violation of felling rules by the contractors and thus, there are no irregular, unscientific and heavy fellings in their clumps with the result the bamboos are not congested and are healthy.

The number of diseased, dead, dry, bushy and bent culms in the clumps of private bamboos of Tika Duhg is only 5% as compared to 14% in C2, 27% in C9 and 21% in

C19 of Reserve Damtal clearly showing a marked distinction between the condition of culms in private area and Reserve Forest. The slightly low figures in C2, 14% can be attributed to the fact that the compartment was last worked in 1970-71 while C9 and C19 were also worked in 1977-78 and 1975-76 and the last fellings in C9 and C19 might have further deteriorated them.

Further, the cleaning and fellings operations also seem to have an effect on the girth of the shoots as would be evident from the figures given under Table 2.

The shoot production in the clump depend on the timely rainfall and its distribution over the rainy season, the condition of the clumps i.e. open, clean, healthy or otherwise, grazing and fire etc. In the present study, it is the poor condition of the clumps chocked with dry bamboos and congestion which are effecting the shoot production; the other factors remaining constant in reserve forest and private area bamboos. Similar type of variation exists in the second year shoots. After second year, it is difficult to classify the shoots year-wise and hence they are clubbed together into mature shoots (75-78%) in Reserve Damtal as compared to culms in the clumps of private bamboos (63%) in which more younger shoots are present. The study established that cleaning and scientific felling of bamboo does enhance the shoot production in the clump. Further, the method of cuttings fellings, intensity of fellings and condition of clumps also effected the number of shoots (culm) in a clump (Table 3). The data clearly show that there are more culms per clump in a scientifically felled and cleaned bamboos. Another very important observation is that the height of the clump and length of the internode in the culm is also dependent on the felling, cleaning and general condition of the clumps (Table 3). The results clearly shows, that internode growth of the shoot is dependent on the various factors such as cleaning, proper or irregular fellings and congestion etc. And rightly, the length of internode is maximum in the clump which are not congested, clean and felled according to rules and regulations. Not only in Nurpur, but in the lower zone of whole Himachal Pradesh, lives of the people, particularly rural are so intrinsically dependent upon bamboo and its varied uses. *Dendrocalamus strictus* is mostly found in the marginal and wastelands of the rural people At maturity, most bamboo clumps attain maximum strength and are reportedly as strong as any wood, weight for weight. The rotation for bamboo is 5-6 years and it can be exploited through three year felling cycle. Yield from plantations of *D. strictus* spaced at 5 m × 5 m is estimated at 3.5 tons/ha per annum.

The above mentioned qualities qualify *D. strictus* as one of the most ideal species for Social Forestry Programmes in the State. It is interesting to note that in Nurpur Forest Division, in many places owners of small number of bamboo clumps do not prefer to sell the bamboo to the contractors for monetary gains but they prefer to cut dead/old bamboos clumps themselves for providing space for growth for shoots and also meeting the domestic demand for various purposes. Villagers also keep the leaves of bushes for the purpose of providing manure for the growth of new shoots before the rainy season. The bamboo

clumps owners held the orthodox view that no felling of bamboo should be done on Monday, Friday and Saturday. Thus, it is the so called illetrate rural people who are most experienced foresters and bamboo managers as regards the bamboo management in private area is concerned. For domestic purposes, the *D. strictus* leaves provide fodder, its seeds are edible and tender shoots serves as delicacies and can be used for making agricultural implements baskets, Bows and arrows, cart containers and Roof, Cart Yokes, Chicks for doors and windows, containers for cleaning grains, construction, cradle, cremation and coffins, fishing rods, furniture, horticultural pursuits, ladders, lattle shats, mats, musical instruments and pandals for shade. No other tree species is as versatile as bamboo.

Under the 65 crore World Bank aided Social Forestry Project which is in operation in the State of Himachal Pradesh, the bamboos can be planted on suitable sites such as loose textured conglomerate on northern aspects in sheltered depression and particularly on well drained slope on favourable aspects and between the elevation 300 to 800 meters both in private land as well as depleted Govt. forests under various components of the project such as Farm Forestry, private wasteland planting, community wood lot (Rain fed) etc. Besides meeting the domestic demand, *D. strictus* when sold to the private contractors by the owner, can be a source of perpetual handsome income every third year as they are worked under three year felling programme. It is estimated that 24 bamboo shoots per clump can be sold to the private contractor every third year at the price of Rs. 10/-per shoot. If a farmer owns 250 clumps in his agricultural marginal or wastelands, he can sell 7200 shoot every third year and thus can get an income of Rs. 72,000/-per 250 clumps every third year. The contractors in turn export the bamboos to Punjab for a wide variety of uses as in Nurpur, there is no handicraft or small scale industry based on the bamboo as a raw material. Handicrafts such as basket making, chick-making for windows and doors, construction of containers for cleaning grains and of agricultural implements, ladders etc. should be encouraged in the rural areas so that employment is provided to rural populatian. The finished products can be exported outside the State and thus bamboos can directly improve the rural economy. The marketing of the finished products may be difficult for which State Govt. should formulate a scheme. The annual estimated production of 50000 bamboos from private area will be sufficient to meet the demand of these small scale industries and handicrafts which may be established individually or co-operative basis. The cleaning and thinning material from Govt. forest may also be provided to the village industries so that rural poverty is alleviated.

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SUMMARY

Bamboos are valuable forests in Himachal Pradesh. Reserve Damtal (210 ha) in Nurpur is a major *Dendrocalamus strictus* bamboo reserve in the State which is being managed under proper working plans from 1903-04. Till 1954, this bamboo reserve was managed under the system of selection fellings and thinning preceded by cleaning, wherever necessary, and biennial fellings were prescribed. The bamboos were worked according to the prescription of working plan resulting in the marked improvement in the condition of the bamboos In 1956-57 this bamboo reserve was leased out to M/s. Gopal Paper Mill, Yamunanagar for 15 years. This firm did reckless irregular and over fellings violating all the rules and regulations The cleanings were not done and biennial cutting proved to be disastrous with the result that this reserve forest has deteriorated to a great extent. These are more unhealthy culms in the clumps, new shoot production has heen seriously affected, number of culms in clump has decreased, size of culms including height, girth and length of internode has been reduced greatly and congestion is common in the clumps. There results have been compared with the private bamboos in Tika Dulig which have been regularly worked and cleaned scientifically and are in a good condition. Steps should be taken to improve the condition of this valuable forest and cleaning and thinning should be carried out beside restocking of the area. *Dendrocalamus strictus* is closely interlinked with the lives of rural people and this is an ideal species for Social Forestry Programme in the State.

डमटाल रिजर्व जंगल में बांसों की दुर्दशा की एक समीक्षा और बांसों का सामाजिक वानिकी में योगदान।

एम०बी० इस्लाम व एच०एस० कंवर

सारांश

बांस के जंगल हिमाचल के लाभदायिक जंगल हैं। रिर्जव जंगल डमटाल जो कि 210 हेक्टेयर है और जिसमें डैण्ड्रोकेलेमस स्ट्रिक्टस पाया जाता है प्रदेश का एक बहुत बडा रिर्जव है जिसको 1903-04 से वैज्ञानिक ढंग से मैनेज किया गया है। 1954 तक इस जंगल को सलेक्शन फेलिंग, थिनिंग, सफाई और दो साल में एक बार कटाई के तहत मैनेज किया गया जिसके नतीजे अच्छे निकले और बांसों की हालत काफी सुधरी। लेकिन इस जंगल को 1956-57 में गोपाल पेपर मिल्स, यमुनानगर को १५ साल के ठेके पर दे दिया गया। ठेकेदार ने अन्धाधुन्ध कटान किया और कटान के कोई कायदे कानून नहीं माने, सफाई भी नहीं की और दो साल, एक बार कटान भी हानिकारक साबित हुआ जिसके नतीजे में इस जगल के बांस बहुत हद तक खराब हो गये। अब बांसों में सूखे, मरे हुए तने बहुत हैं। नये तने निकलने पर खराब असर पड़ा है, झुंड में तनों की संख्या कम हो गई है। तनों की लम्बाई, चौडाई और इन्टरनोड की लम्बाई कम हो गई है, व इन नतीजों को प्राइवेट डूहग के बांसों से मुकाबला किया गया है जिनमें कि लगातार अच्छे ढग मे कटान और सफाई हुआ है। इस जगल के बांसों के हालात अच्छे करने चाहिए और सफाई व थिनिंग करनी चाहिए और पौधारोपण भी करना चाहिए। डैण्ड्रोकेलेमस स्ट्रिक्टस गांव के लोगों की जिन्दगी से सम्बंधित है और यह सामाजिक वानिकी के कार्यक्रम में बहुत सहायक साबित हो सकता है।

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RAINFALL INTERCEPTION BY *PINUS WALLICHIANA* PLANTATION IN TEMPERATE REGION OF HIMACHAL PRADESH, INDIA

R.P. SINGH

Environmental Research Station, Shimla, (Himachal Pradesh)

Introduction

Interception refers to that part of the precipitation retained by the aerial part of vegetation which is either absorbed by it or evaporated. The loss through interception is computed by measuring the precipitation that falls through the canopy (throughfall) and rain-water that runs down tree trunk (stemflow) and then sub-tracting the sum of these two from precipitation measured in open clearings or outside the forest (Stanhill, 1970).

Generally, forests are the most effective agents in reducing erosion because of their canopy which intercepts the rainfall so that its kinetic energy is dissipated by the aerial portion of the trees rather than imparted to the soil. Interception is one of the important components of hydrological cycle which effects the movement of water into soil, moisture budget and runoff which in turn is, however, responsible for soil erosion, floods etc. Interception studies have been conducted by different workers in India as well as abroad under different canopy covers (Dabral and Rao, 1968, 1969; Ghosh *et al.*, 1980; Hamilton and Rowe, 1949; Singh *et al.*, 1983; Stanhill, 1970 and Voigt, 1960). In the present study, an attempt has been made to quantify the stem-flow throughfall and interception loss in *Pinus wallichiana* plantation in temperate region of Himachal Pradesh (India).

Details of the experimental site and stand

Interception studies were carried out in *Pinus wallichiana* plantation at Shillaroo (Longitude 31° 13′ 45″ N, Latitude 77° 26′ 48″E), Kotgarh Forest Division of Shimla district (Himachal Pradesh), 55 km from Shimla on Shimla-Narkanda Road at 2400 m elevation above the mean sea level. The soil is clay loam and silt clay loam having pebbles and stones at depths varying from 1-2 m (Singh *et al.*, 1983). The parti-culars of *Pinus wallichiana* plantation are given in Table 1.

Table 1

Particulars of Pinus wallichiana plantation

Area of study plot	—	0.021 ha. (14.0 m × 15.5 m)
Age of plantation	—	20 Years (approximately)
Average spacing	—	3 × 3 m
No. of trees in the plantation/ ha	—	1200
Average DBH	—	17.56 cm
Average height	—	14.78 m
Crown density	—	81%

The average value of five years climatological data of this site is presented in Table 2.

Table 2

Mean monthly rainfall, humidity and temperature (Average of 5 years 1980-84) of Shillaroo (H.P.)

Month	Rainfall (mm)	Temperature °C			Relative Humidity %	
		Max.	Min.	Mean	0830 hrs.	1400 hrs.
Jan.	—	10.35	-0.41	4.97	63.46	56.96
Feb.	3.63	9.66	-0.62	4.52	60.77	57.96
Mar.	33.51	12.57	3.10	7.83	56.68	52.79
Apr.	106.40	16.73	6.87	11.80	53.67	48.76
May	109.85	21.02	10.97	15.99	51.56	49.54
June	143.86	23.08	14.02	18.55	70.34	63.76
July	204.18	22.15	13.98	18.06	87.96	84.73
Aug.	174.33	22.15	15.69	18.92	94.30	89.06
Sept.	60.60	22.01	11.80	16.90	78.39	70.82
Oct.	211.33	19.90	7.73	13.81	61.76	50.77
Nov.	1.80	16.59	3.55	10.07	57.57	48.22
Dec.	—	12.79	2.12	7.45	52.27	51.41
Average :	859.49	17.41	07.40	12.40	65.72	60.39

Material and Method

The present study was started in June, 1982 at Shillaroo and data recorded upto May, 1984. Enumeration of all the trees in the plantation was done and their diameter at breast height ranged from 8.7 to 37.8 cm. The trees were grouped into three diameter classes for the purpose of measuring stemflow. Details are given in Table 3.

Table 3

Diameter of trees in the interception plot under different diameter classes in Pinus wallichiana plantation

Diameter class	Diameter of trees fitted with collars (cm)		
< 15 cm	(i) 11.30	(ii) 13.05	(iii) 13.20
	(iv) 13.89	(v) 14.32	(vi) 14.38
15-25 cm	(i) 15.34	(ii) 17.02	(iii) 17.04
	(iv) 17.18	(v) 17.34	(vi) 18.46
	(vii) 19.41	(viii) 20.69	(ix) 20 84
	(x) 21.16	(xi) 23.87	(xii) 24.35
25-35 cm	(i) 26.73	(ii) 27.37	(iii) 28.64

Thus, a total of 21 trees were selected for stemflow measurements under different diameter classes with the help of metal collars, fitted at breast height, having one metal spout of suitable diameter and length at the base of each collar for water to flow out. Each spout was connected with a rubber tube of suitable length, for collecting the stemflow, to empty tins (23.5 × 23.5×35.0 cm), which were covered properly to check direct rain falling into containers. At the time of collar fitting and also at different times, it was ensured that the collar was watertight at the base by the sealing with 'Putty'. Throughfall was collected in empty tins (same size as above) by placing them in rows (1.5 m tin to tin in row and 2.0 m distance between the two rows) in the plot selected for the study. The water collected in stemflow and throughfall tins was measured after each storm with the help of a measuring cylinder. The quantity of water measured in litres was then converted into mm depth on the study area by computation. A raingauge was installed in an open plot near the experimental site for measuring the gross rainfall.

A linear relationship has been developed between gross rainfall (mm) and stemflow (mm), throughfall (mm), as well as interception loss (mm) by using the simple regression equation :

$$Y = a + bx$$

where Y, is independent variable and
X, is dependent variable

Results and Discussions

Stemflow, throughfall and interception on monthly basis for the period from June, 1982 to May 1984, in *Pinus wallichiana* plantation both in terms of quantity and persentage of the total rainfall is presented in Table 4. The quantity of stemflow is lower (2.7%) than that of throughfall (76.2%) of the total rainfall for the whole period of the study Of the total rainfall (1327.20 mm), 36.27 mm was stemflow; 1011.82 mm throughfall and 279.11 mm interception respectively. Interception was recorded 27.5% and stemflow 3.5% in respect of throughfall for the whole observation period respectively while stemflow was observed 12.9% of the total intercepted water. Interception loss was recorded 21.0% in *Pinus wallichiana* plantation.

The maximum interception of rainfall (75.0%), was observed in March, 1984, which had the lowest (4.00 mm) rainfall, while the minimum interception (10.0%) was recorded in August, 1983, the month which had the maximum (198.00 mm) rainfall. In case of maximum interception in the month of March, 1984, throughfall percentage (25.0%) was minimum and sten flow was nil. On the other hand, in the month of August 1983, which had the minimum interception and maximum rainfall, the throughfall percentage (86.1%) was maximum while the stemflow percentage (3.5%) was recorded maximum in the month of October, 1983. The amount of stemflow depends largely upon the roughness of the bark (Singh *et al.*, 1983). The amount of rain at which stemflow starts may be lower for smooth-bark species like *Fagus sylvatica* than that of rough-bark species like conifers. Interception loss decreased with the increasing amount of rainfall. The amount of interception is primarily controlled by four factors, viz. species of vegetation, growth stage of vegetation, season of year and wind velocity.

Table 4

Stemflow, throughfall and interception loss in Pinus wallichiana

Year & months	Rainfall (mm)	Stemflow		Throughfall		Interception	
		(mm)	(%)	(mm)	(%)	(mm)	loss (%)
1982							
June	94.60	2.31	2.44	69.59	73.56	22.70	23.99
July	108.00	2.66	2.46	80.39	74.43	24.95	23.10
Aug.	113.20	3.34	2.95	85.37	75.41	24.49	21.63
Sept.	18.60	·0.08	0.43	12.72	68.38	5.80	31.18
Oct.	15.20	0.03	0.19	9.20	60.52	5.97	39.27
Nov.	7.20	0.00	0.00	3.20	44.44	4.00	55.55
1983							
Mar.	8.00	0.00	0.00	3.80	47.50	4.20	52.50
Apr.	126.90	2.73	2.15	97.78	77.05	26 39	20.79
May.	155.80	4.62	2.96	121.15	77.99	29.67	19.04
June	104.00	2.86	2.75	76.77	73.81	24.37	23.43
July	158 00	4.79	3.03	128.91	81.58	24.30	15.37
Aug.	198.00	6.30	3.16	171.75	86.18	19.97	10.08
Sept.	91.40	2.37	2.59	66.29	72.52	22.74	24.87
Oct.	60.60	2.17	3.58	41.98	69.27	16.45	27 14
Nov.	6.00	0.00	0.00	2.58	43.00	3.42	57.00
1984							
Mar.	4.00	0.00	0.00	1.00	25.00	3.00	75.00
Apr.	57.70	2.10	3.48	39.00	67.59	16.69	28.92
May	—	—	—	—	—	—	—
Average :	1327.20	36.27	2.73	1011.82	76.23	279.11	21.02

From December, 1982 to February, 1983 and December, 1983 to February, 1984 there was snowfall and no rainfall as in May, 1984.

Fig. 1

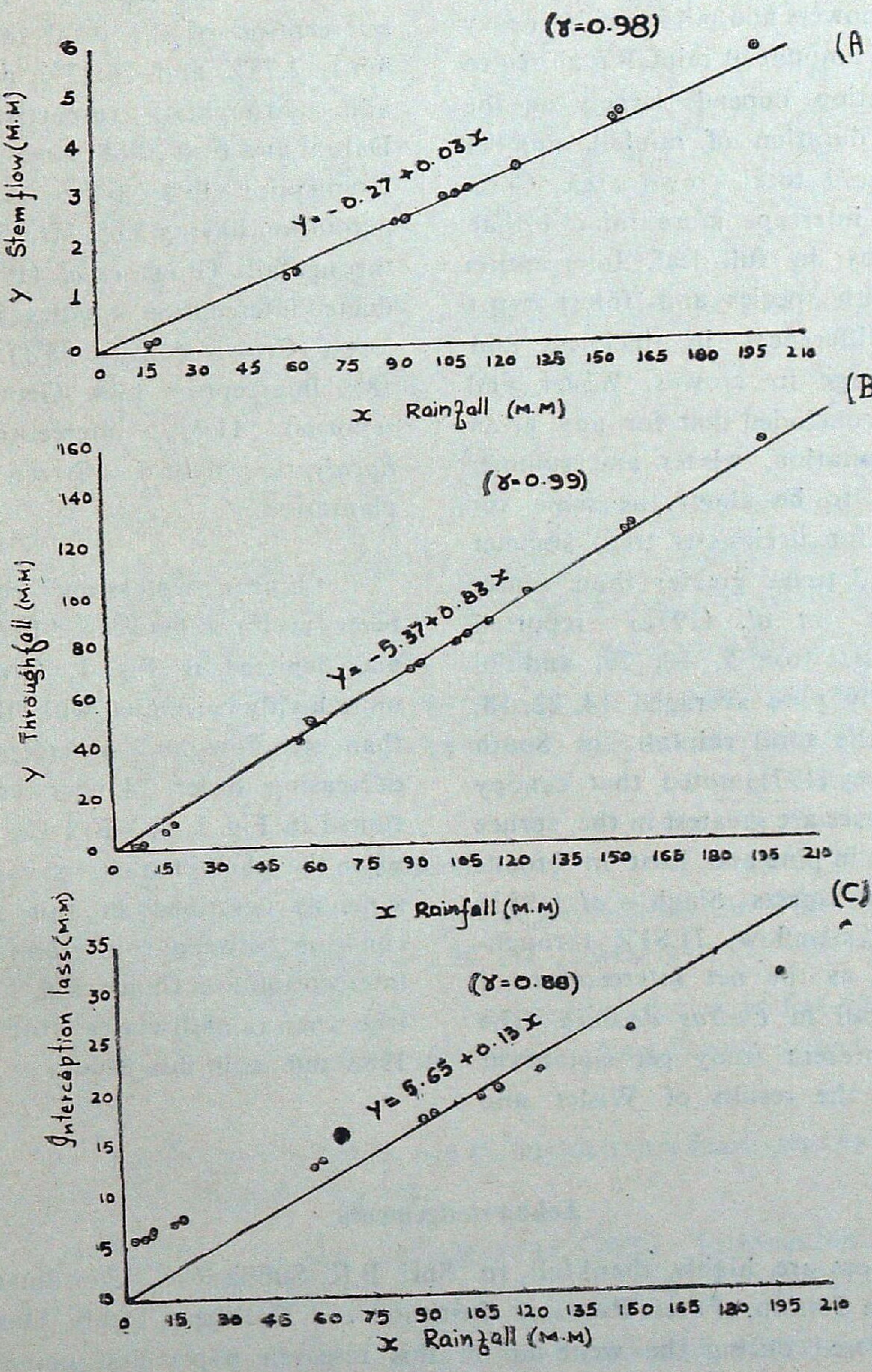

Fig. 1A – Depicts the correlation and linear regression equation between stemflow (mm) and total rainfall (mm) and Fig. 1B - Indicates the correlation and linear equation between throughfall (mm) and total rainfall (mm). Fig. 1C – Shows the correlation and linear equation between interception loss (mm) and total rainfall (mm).

The interception loss for the whole study period varied from 10.08 to 75.00%. Canopy withheld maximum interception during light showers and minimum in heavy showers. The amount of rainfall required to wet the vegetation depends largely on the intensity and duration of rainfall, number of rainy days and total crown area Coniferous trees intercept more rainfall than deciduous trees in full leaf. Interception loss varies with species and forest types because of differences in thickness and density of foliage in crowns. Wisler and Brater (1959) concluded that for any given depth of precipitation, winter and summer losses appear to be about the same for conifers, but for deciduous trees summer losses are 2 or 3 times greater than winter losses. Swank *et al.* (1972) reported interception losses from 5, 10, 20, and 30 year old loblolly pine averaged 14, 22, 18, and 18% of the total rainfall in South Carolina. Helvey (1971) noted that canopy interception losses are greatest in the spruce fir intermediate in pine and least in broadleaved deciduous forests. Singh *et al.* (1983) reported 2.99% stemflow, 71.81% throughfall and 25 20% as the net interception of the total rainfall in *Cedrus deodara* The results of the present study get significant support from the results of Wisler and Brater (1959). Swank *et al.* (1972) and Singh *et al.* (1983). In present study, *Pinus wallichiana* intercepts 21 02% as the net interception of the total rainfall (1327.20 mm), 2.73% and 76 23% as the stemflow and throughfall respectively (Table 4). Dabral and Rao (1968) have estimated 22% interception loss under *Pinus roxburghii* plantation having 3.6% stemflow and 74.3% throughfall. Ghosh *et al.* (1980) have conducted interception studies in Sal coppice forest (Crown density 88%) and observed 18% interception loss. George (1978) has reported 11.5% interception loss in *Eucalyptus* hybrid (Crown density 84%) plantation.

Linear regression equations have been developed between different attributes and depicted in Fig. 1. Gross rainfall is more highly correlated with the throughfall than stemflow and interception loss in decreasing order. Linear equations mentioned in Fig. 1 A, 1 B, 1 C., can be applied when the stand characteristics are about the same as described in this study. Linear equation between total rainfall (mm) and interception loss (mm) (Fig. 1 C) only holds true when rainfall varies from 4.00 mm to 198.0 mm as in this study.

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SUMMARY

The present investigation deals with the rainfall interception by *Pinus wallichiana* plantation in temperate region of Himachal Pradesh. Of the total rainfall (1327.20 mm). 2.73% (36.27 mm) stemflow; 76.23% (1011.82 mm) throughfall and 21.02% (279.11 mm) interception loss were recorded respectively for the whole study period. The minimum interception loss (10.08%) was observed in the month of August, 1983 which had the maximum (198.00 mm) rainfall. The highest interception (75.00%) was recorded in the month of March, 1984, which had the lowest (4.00 mm) rainfall. Interception loss was decreased with the increasing amount of interception.

हिमाचल प्रदेश, भारत के समशीतोष्ण प्रदेश में लगे पाइनस वालिशियाना रोपवन द्वारा वर्षा अवरोधन

आर०पी० सिंह

सारांश

प्रस्तुत अन्वेषण हिमाचल प्रदेश के समशीतोष्ण प्रदेश में पाइनस वालिशियाना रोपवन द्वारा वर्षा अवरोधन से सम्बधित है। कुल वर्षा (1327.20 मिमी) में 2.73% (36.27 मिमी०) स्तम्भ प्रवाह, 76.23% (1011.82 मिमी), प्रत्यक्ष पतन और 21.02% (279.11 मिमी) अवरोध द्वारा हानि इस पूरे अध्ययन की अवधि में क्रमश: अभिलिखित किए गए। न्यूनतम अवरोध हानि (10.08%) अगस्त 1983 मास में देखी गई जिसमें वर्षा भी अधिकतम (198 00 मिमी) रही। अधिकतम अवरोधन (75.00 %) मार्च 1984 मास में अभिलिखित किया गया, जिसमें वर्षा सबसे कम (4.00 मिमी) हुई। वर्षण जितना बढ़ता गया अवरोधन हानि घटती चली गई।

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PHYSICAL AND MECHANICAL PROPERTIES OF *ACACIA AURICULAEFORMIS* FROM KARNATAKA

P. KUMAR, A.K. ANANTHANARAYANA AND S.N. SHARMA*

Forest Research Laboratory, Bangalore (Karnataka)

Introduction

Acacia auriculaeformis is native to the Savannas of Papua New Guinea, the islands of Torres Strait and the northern areas of Australia. Because of its ability to grow on very poor soil, it has been introduced into countries such as Indonesia, Malayasia, Tanzania and Nigeria. It is a vigorously growing tree, reaching a height of 30 metres and trunk upto 60 cms in diameter under the native conditions. An attractive ornamental shade tree, it requires little attention. Material from 10-year old trees from Papua New Guinea plantations was found to give high yield of pulp with good strength properties (Anon., 1980).

This species was introduced in India two to three decades back, recognizing its ability to grow on poor soils and in areas with extended dry season. Currently, it is one of the recommended species for firewood farming in degraded lands (Chaturvedi, 1985) because of its excellent quality of firewood, which burns without smoke or spark and has a calorific value of 4800 to 4900 Kcals per kg (Anon., 1980). It has been grown as an avenue tree in Tamil Nadu, Bihar and West Bengal and as fuelwood plantations in Dharwar and other areas of Karnataka, where it is known by the local names 'Bangala Jali' and 'Haldimese mara'. The plant grows very vigorously in the early stages.

In this paper the physical and mechanical properties of this species are reported with a view to assessing its suitability for various end uses as timber, apart from fuelwood use.

Material and testing procedures

The material for tests was available only from trees of approximate age of 14 years. Eight logs of length 2 metres and girth 0.7 metres belonging to 3 different trees were procured from Mudigere Forest Experimental Station, Karnataka. The layout and conversion of the specimens, both for tests in the green and air-dry conditions, was carried out generally as per I.S. Specification IS : 2455-1974. Testing Procedures specified in the Indian Standard IS : 1708 : 1969 were adopted, except in case of static bending and compression parallel-to-grain for which specimens of 2.5 × 2.5 cms cross section were used due to the limited capacity of the testing machine (Mohr-Federhaff A-G Universal Testing Machine of 10 tonnes capacity). The material was tested both in green and air-dry conditions.

Results

The results obtained on various properties of *Acacia auriculaeformis* are presented in Table 1. Average values of all

* Presently Director, Forest Products Research, F.R.I. & Colleges, Dehra Dun.

Table 1

Data on the Physical and Mechanical properties of Acacia auriculaeformis from trees of approx. 14 years age.

Properties	Green						Air dry		*Tectona grandis* (Std. teak)		Improvement factor (%)
	Average	Max.	Min.	S.D.	C.V (%)	Expected	Average	Expected	Green Average	Air-dry Average	
1	2	3	4	5	6	7	8	9	10	11	12
Sp. gravity (based on oven dry wt and volume on test)	0.747	0.917	0.654	0.04	5.3	—	0.722	—	0.596	0.604	—
% moisture content	48.1	71.6	30.0	8.9	18.5	—	12	—	76.6	12	—
Weight (kg/m^3)	1103	—	—	—	—	—	830	—	1056	672	—
Static bending :											
(a) F.S. at elastic limit (kg/cm^2)	640	747	427	59.8	9.3	509	970	668	509	651	51.5
(b) Modulus of rupture (kg/cm^2)	1081	1273	836	82.7	7.6	861	1473	1154	841	959	36.3
(c) Modulus of elasticity (1000 kg/cm^2)	113.5	156.4	66.3	20.4	18.0	123.9	160.5	150.4	109.7	119.6	41.4
Compression parallel to grain :											
Maximum crushing stress (kg/cm^2)	476	617	371	60.7	12.7	432	736	637	415	532	54.6
Compression perpendicular to grain :											
Compressive stress at E.L. (kg/cm^2)	109	127	79	13.8	12.7	105.6	125	129.5	86	101	14.7

(Contd...)

1	2	3	4	5	6	7	8	9	10	11	12
Hardness (load to embed 1.128 cm dia steel ball to half its diameter)											
(a) Radial (kgs)	827	1050	650	70.9	8.6	768	1134	932	557	502	37.1
(b) Tangential kgs)	801	1050	620	76.9	9.6	727	1095	908	551	524	36.7
(c) End (kgs)	945	1200	730	102.5	10.8	739	1348	947	486	488	42.6
Shear parallel to grain :											
(a) Radial (kg/cm²)	92.6	123.5	59.9	20.0	21.6	100.8	103.5	124.8	89.5	96.6	11.8
(b) Tangential (kg/cm²)	104.1	126.3	72.0	17.6	16.9	112.9	148.5	135.7	100.2	108.0	42.6
Tension perpendicular to grain :											
(a) Radial (kg/cm²)	36.2	64.4	23.6	10.3	28.4	49 6	45.3	43.7	68.3	57.6	25.1
(b) Tangential (kg/cm²)	49.2	62.4	40.0	5.6	11.4	61.5	48.5	58.6	79.4	66.4	—1.4
Nail holding Power :											
(a) Side (kgs)	218	242	200	10.7	4.9	191	112	—	127	—	—48.6
(b) End (kgs)	174	207	145	17.4	10.0	143	79	—	91	—	—54.6
Screw holding power :											
(a) Side (kgs)	454	567	380	44.2	9.7	432	403	—	331	—	—11.2
(b) End (kgs)	319	402	235	52.5	16.4	273	214	—	236	—	—32.9

Table 2

Safe working stresses of Acacia auriculaeformis

(Tested trees of approx. 14 yrs age)

Working Stresses	Location		
	Inside	Outside	Wet
Extreme fibre stress in beam (kg/cm²)	216 (168)	180 (140)	144 (112)
Shear along grain (kg/cm²)	15.4 (14.9)	15.4 (14.9)	15 4 (14.9)
Horizontal shear in beams (kg/cm²)	10.8 (10.4)	10.8 (10.4)	10.8 (10.4)
Maximum compressive stress parallel to grain (kg/cm²)	119 (104)	106 (92)	87 (75)
Compressive stress perpendicular to grain (kg/cm³)	63 (49)	49 (38)	40 (31)

Figures in brackets shows corresponding values of standard teak (*Tectona grandis*).

Table 3

Suitability indices of Acacia auriculaeformis in terms of teak taken as 100

(Tested trees of approx. 14 yrs. age)

Properties	Suitability indices
Strength as a beam	132
Stiffness as a beam	114
Suitability as a post	112
Shock resisting ability*	116
Shear	110
Refractoriness (Splitting Co-efficient)	63
Hardness	160
Nail holding power	138
Screw holding power	116
Weight or Heaviness	123

* Figure based on data computed from strength—Sp. gravity relationship.

the strength properties in green condition with their maximum and minimum values, standard deviation and co-efficient of variation calculated for all the properties, and the average strength values of the material in air-dry condition adjusted to 12% m.c., in accordance with Table 4, Sl. No. (ii) b and Clause 4.2 of IS : 8745-1978, are given. The nail and screw holding properties were tested under the following two conditions :

(i) Driven in green condition and withdrawn at once.

(ii) Driven in air-dry condition and withdrawn at once.

Strength values of "Standard teak" (Sekhar & Rawat, 1966) determined under similar conditions of material are also given in Table 1 for purpose of comparison. Expected strength values for *Acacia*

auriculaeformis which are mentioned in the Table were calculated using the Strength-Specific gravity relationship (Sekhar & Rawat, 1959), for both green and air-dry conditions. Improvement factors indicating the percentage increase in the observed values of various strength properties from green to air-dry condition were also computed and are given in the Table.

In Table 2, the safe working stresses which were calculated by the usual method (Sekhar & Rajput, 1972) for inside, outside and wet locations are given along with the corresponding values of "Standard teak" for purposes of comparison.

As usual, the comparative suitability indices for various end uses were calculated as percentage of "Standard teak" using the standard formulae (Sekhar & Gulati, 1972) and the results are given in Table 3.

Discussion

It is seen from Table 1 that the strength values of air-dry material are substantially higher than those of green material by 25.1% to 54.6% for most of the properties, except for compressive stress at E.L., shear parallel-to-grain in the radial direction, tension perpendicular-to-grain in the tangential direction, nail and screw holding power. The improvement if any in air-dry values over green values has been marginal in case of compressive stress at E L and shear parallel-to-grain in the radial direction. Air-dry values are substantively lower than the green values by 11.2% to 54 6% in case of Nail and Screw holding power while they are almost equal to the green values in case of tension perpendicular-to-grain in the tangential direction.

On comparing the observed values with the expected in the green condition, it is found that the observed values are on an average 16.5% higher than the expected values in most of the properties except in modulus of elasticity in static bending, shear parallel-to-grain and tension perpendicular-to-grain in which they are less by 14 3% than the expected values. In compressive stress at E.L. the observed and expected values are almost equal. A similar comparison of strength of air-dry material indicates that in general the observed values are higher than the expected by 23 6% in respect of all properties, except in shear parallel-to-grain in radial direction and tension perpendicular-to-grain in the tangential direction in which on an average they are 17.1% lower than the expected values. The observed and expected values are almost equal for compressive stress at E.L. and tension perpendicular-to-grain in the radial direction.

Further, by comparing the green and air-dry values of *A. auriculaeformis* with the corresponding values of teak, it is observed that the strength values of *A. auriculaeformis* are much higher than teak in both green and air-dry conditions, except in tension perpendicular-to-grain where the values are 43% less than teak in green condition and 24% less in air-dry condition. In modulus of elasticity in Static bending and shear parallel-to-grain in green condition the values for *A. auriculaeformis* are almost equal to those for teak but are higher in the air-dry condition.

On comparing the safe working stresses of *A. auriculaeformis* with the corresponding values of teak given in Table 2, it is seen that extreme fibre stress,

maximum compressive stress parallel-to-grain and compressive stress perpendicular-to-grain are higher than teak by 28.6%. 15.2% and 28.8% respectively, whereas safe working stresses in shear (horizontal as well as along the grain) are almost equal to those for teak.

In order to assess the utilization of this timber, suitability indices expressed as a percentage of teak for various purposes are given in Table 3.

According to usual classification of timber species, (Sekhar & Gulati, 1972), *A. auriculaeformis* can be classified as very heavy, extremely strong, moderately tough and extremely hard.

The turning and finishing properties of *A. auriculaeformis* were first tested with regard to its possible use in the toy making industry by Rajan *et al.*, 1979. Further tests have recently been undertaken on thoroughly air-dried material and it has been confirmed that the wood can be turned and sanded to a smooth finish on powered lathes. The turning even on the end grain surface is smooth and the edges obtained in profile are quiet sharp. The wood takes excellent lacquer finish and the figure obtained under clear lacquer has been considered acceptable for export turnery products like bangles, beads, flower vases, powder boxes etc. The wood can be planed to a smooth surface on a rotary planer except in portions containing cross grain and knots. The colour of dry-wood in the outer heartwood is a pleasant light brown and in the interior heartwood the colour and figure are dark brown with some resemblence to teak.

It appears to be an excellent wood for turnery articles, toys, carrom coins, chess-men and handicrafts as at present the trees are generally harvested only as a short-rotation crop mainly for fuelwood. However, on the basis of its strength, nail and screw holding properties and working characteristics it may be well worth trying for furniture, joinery, flooring and tool handles besides cons tructional purposes, if trees of suitable girth are available.

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SUMMARY

Physical and mechanical properties and suitability indices of *Acacia auriculaeformis*, an exotic species currently finding favour for firewood farming, have been evaluated. The data suggests that this species would be well worth trying for furniture, joinery, flooring, constructional purposes and tool handles besides turnery articles if logs in suitable girths are available.

कर्नाटक से प्राप्त अकेसिया औरिकुलीफार्मिस की भौतिक और संधारी विशिष्टताएँ

पी० कुमार, ए०के० अनन्तनरायण व एस०एन० शर्मा

सारांश

बाहर से आई हुई प्रकाष्ठ जाति अकेसिया औरिकुलीफार्मिस की, जिसे आजकल ईंधनकाष्ठ उत्पादन के लिये पसद किया जा रहा है, भौतिक एव संधारी विशिष्ठताएँ तथा उपयुक्तता निर्देशांक मूल्यांकित किए गए है। इन आंकड़ों से प्रतीत होता है कि इस प्रकाष्ठ जाति को उपस्कर, बढईगिरी, फर्श बनाने, भवन निर्माण औजारों के बेंटे और खरादकार्य के लिए उपयोग करके देखना चाहिए बशर्ते कि उपयुक्त गोलाइयों के इसके लट्ठे मिल सकें।

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ASYMBIOTIC SEED GERMINATION AND SEEDLING DEVELOPMENT IN *COELOGYNE PUNCTULATA* AND *AERIDES MULTIFLORUM*

R.S KATIYAR,* G.D. SHARMA AND R.R. MISHRA

Botany Department, School of Life Sciences,
North-Eastern Hill University, Shillong (Meghalaya)

Introduction

Orchid, a dominant epiphytic vegetation in subtropical forests of N.E. India, represents 6.5% of total orchid species of the globe. The prevalent practice of shifting cultivation in the region has caused a fast degradation of the orchid wealth. Human activities have, therefore, promoted the rate of extinction of orchid species and threatened their survival. This has resulted into a dwindling population of orchids in recent past. The seeds of orchid are tiny and lack endosperm to provide the nutrient required for germination. Some studies on symbiotic and non-symbiotic orchid seed germination have been carried out (Warcup, 1973 and Arditti, 1967), however, little success is achieved in raising the seedling of rare orchid species.

Material and Methods

The *Coelogyne punctulata* (Lindl). and *Aerides multiflorum* (Roxb.), are rare orchids, found in tropical forests of Meghalaya (Garo Hills). The green pods of *C. punctulata* and *A. multiflorum* were collected, sterilized with 5% Sodium hypochlorite and rinsed with sterilized water. The seeds of *A. multiflorum* and *C. punctulata* were taken out with the help of sterilized needle and sown on Knudson's C medium (Arditti, Michaud and Oliva; 1981) added with 100 gm ripe banana pulp/litre. pH of the medium was adjusted to 5.0 before autoclaving. The sown seeds in culture tubes were incubated at 25$\pm$ 2°C in dark upto protocorm stage. The percentage of germination was calculated based on 100 seeds observation. After the formation of protocorms they are exposed to 1300 lux light intensity at 12 hour interval. Number of root and leaf formation was counted and their length and width was measured after six months of germination. For fresh weight calculation seedling were removed from the medium and washed thoroughly. Extra water was absorbed with Whatman filter paper before weighing. Twenty replicates were maintained for each parameter.

Results and Discussion

The seeds of *C. punctulata* germinated faster i.e. 81 4% in 90 days but germination of seeds in *A. multiflorum* was slow i.e. 60.8% in 90 days. The first symptom of seed germination was observed in the form of swelling of embryo and then enlargement and differentiation of the tissue was noted (Arditti, 1966). The differentiation of leaf and root primordia started at opposite sides

* Presently at C.S.R. & T.I,, Srirampura, Mysore (Karnataka).

of the germinated embryo. Before developing further embryo appears like a callus or pseudobulb (Plate 1 A). The development

Plate 1

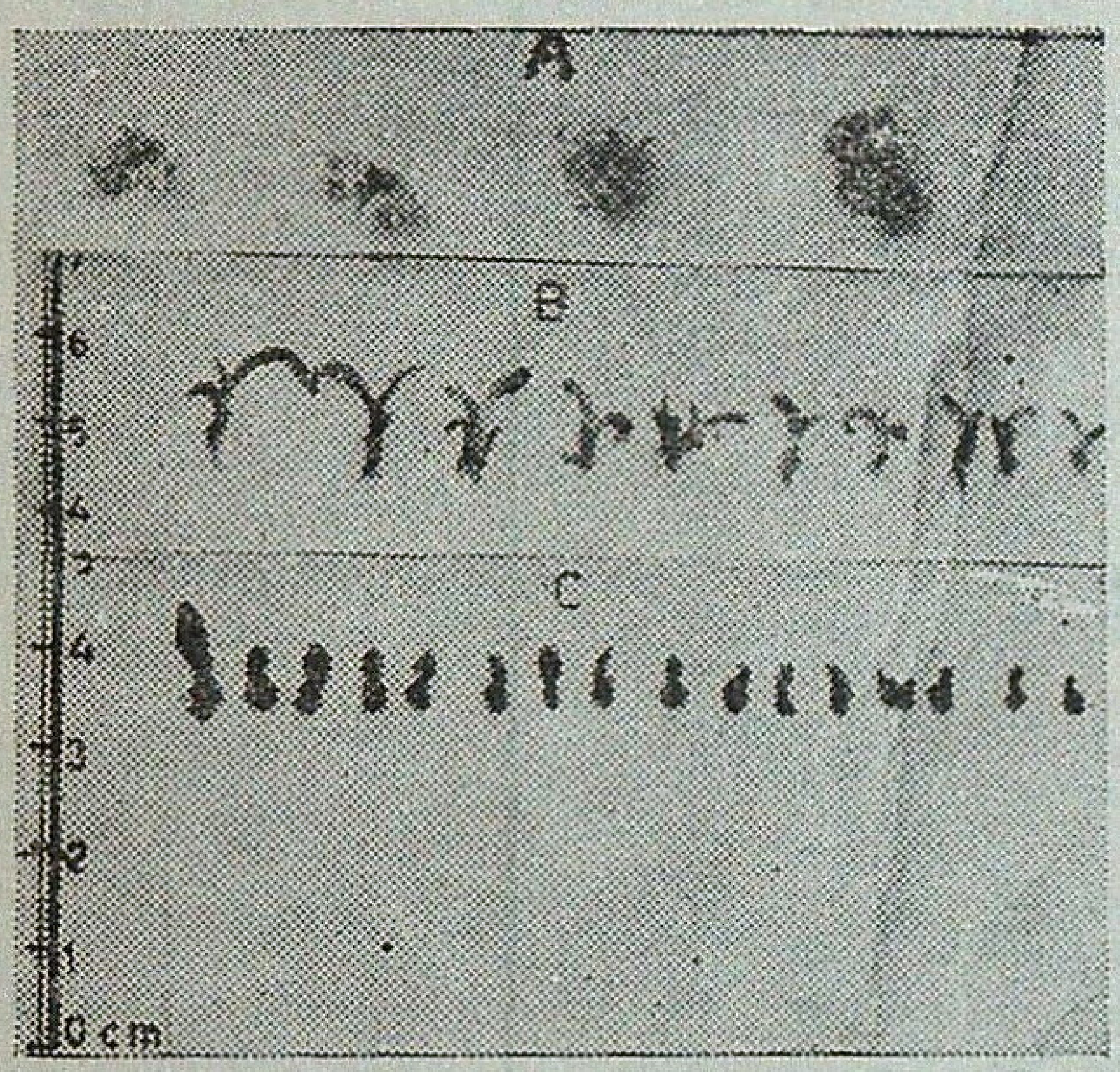

Fig. A : Callus like structure in *C. punctulata*.

Fig B and C : Showing developmental stages in *C. punctulata* and *A. multiflorum* seedlings respectively.

of two leaves stage was observed after 120 days in *C. punctulata* but at the same time no leaf formation was noticed in *A. multiflorum*. In the case of *A. multiflorum* bulb production was more distinct than *C. punctulata*. The root number and the length was more in *C. punctulata* than in *A. multiflorum* (Table 1). Though *A. multiflorum* did not produce more leaves, the fresh weight of seedlings did not differ significantly than that of *C. punctulata*. In *A. multiflorum* more fresh matter was produced in the form of bulb, whereas, in *C. punctulata* the fresh weight was distributed in leaf, stem and root. In *A. multiflorum* width of single leaf and diameter of root were more than *C. punctulata* (Table 1 and Plate 1).

Epiphytic orchid's seeds of both the types germinated asymbiotically *in vitro*. The asymbiotic germination of seeds could occur on rich nutrient medium (Knudson, 1952); which could substitute the fungal symbiont requirement for seed germination in controlled conditions. Certain additives like banana pulp and juice activated charcoal, tomato juice and pineapple pulp have shown to exhibit stimulatory effect on orchid seed germination. The orchid seeds dependency on fungal symbiont is attributed mainly for getting simple carbohydrates through it (Arditti, 1969). Therefore, the undefined sugars, amino acids and growth factors in medium may have inducive effect on asymbiotic seed germination of orchids. Species variation in germination and seedling growth could also be accounted due to certain environmental factors (Arditti, 1967) but the role of genetic factors can not be ignored. Some species prefer dark conditions while others may have better germination in light conditions (Darnell, 1952 and Knudson, 1950). Temperature has also been found to exert the differential effect on orchids. The organ differentation depends on the genetic and physiological activities of the species. But the fresh weight study of these species revealed that insignificant variation was due to similar biomass production which may be in different forms i.e. in leaf stem and root in case of *C. punctulata* and in bulb, root and leaf forms in the case of *A. multiflorum*. This variation could also be related to their special differences. However, the detailed studies on the factors that influence orchid seed germination will provide more informations which are in progress.

Table 1

Asymbiotic seed germination and early development of seedlings in orchids

Orchid species	Germination (%) after 90 days	Average development						Average fresh weight of per seedling (mg)
		Av. No. of leaf	Av. length of leaf (mm)	Av. width of leaf (mm)	Av. No. of root	Av. length of root (mm)	Av. Diameter of root (mm)	
Aerides multiflorum (Roxb.)	60.8	1.0 (±0.53)	3.5 (±2.05)	2.8 (±1.26)	1.0 (±1.10)	1.2 (±1.36)	0.91 (±0.91)	9.5
Coelogyne punctulata (Lindl.)	81.4	4.0 (±1.96)	5.5 (±11.19)	1.5 (±2.96)	4.0 (±2.23)	2.1 (±4.79)	0.5 (±0.88)	11.0

Figures in parenthesis represent the Standard Error (S E.)

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SUMMARY

Asymbiotic germination of *C. punctulata* **and** *A. multiflorum* **was carried out** *in-vitro*. **The variation in germination and seedling growth was observed and it was found that** *C punctulata* **germinates faster than** *A. multiflorum*. **The seedlings of** *C. punctulata* **were more vigorous than** *A multiflorum* **after 180 days of their sowing.**

सीलोग्यने पंक्टु लेटा और एअराइड्स मल्टीफ्लोरम की सहजीवी बीजांकुरण और बीजांकुरों का बिकास

आर०एस० कटियार, जी०डी० शर्मा व आर०आर० मिश्र

सारांश

सी० पंक्टुएलेटा और ए० मल्टीफ्लोरम के सहजीवी अंकुरण का एक परीक्षण काच में किया गया। अंकुरण और बीजांकुर वृद्धि म हुए परिवर्तन पर नजर रखी गई और यह पाया गया कि ए० मल्टीफ्लोरम की अपेक्षा सी० पक्टुएलेटा बढ़ने में तेज है। बोने के 180 दिन बाद ए० मल्टीफ्लोरम के पौधे की तुलना में सी० पंक्टुएलेटा के पौधे अधिक ओजस्वी थे।

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SEED GERMINATION OF SOME BAMBOO SPECIES

RATAN LAL BANIK

Silviculture Genetics Division,
Forest Research Institute, Chittagong (Bangladesh)

Introduction

The main sources of natural bamboo in Bangladesh are the forests of Sylhet, Chittagong, and the Chittagong Hill Tracts. To meet the increasing demand for bamboo, there is an urgent need for establishing bamboo plantations. The species naturally growing in the forests of Bangladesh are mostly thin-walled (>1.0 cm) and show comparatively poor results in different methods of vegetative propagation than the thick-walled bamboo species, generally cultivated in the villages (Hasan, 1973). As such it becomes difficult and uneconomic to undertake any large scale plantation of thin-walled bamboos only through clonal propagation (Banik, 1980).

Propagation of bamboo through seeds is also limited due to its long and irregular interseeding period. However, scientific knowledges on the morphology, germination and longevity of bamboo seeds are important for their proper utilization at the time of availability. In this connection, plantations of *Bambusa arundinacea*, *B. burmanica* and *Dendrocalamus strictus* have been raised successfully from seeds in India by Rao (1920), and Andiappan and Wilson (1963). Bamboo produces one seeded fruit with thin pericarp adnate to the seed coat, is known as *caryopsis* covered with a number of persistent glumes (Gamble, 1866; Gould 1968). In this paper the term *seed* will be used in lieu of *caryopsis* for better understanding to the field foresters.

The germination capability and longevity of seeds of various species of bamboo were, therefore, studied in support of establishing plantation in Bangladesh.

Materials and Methods

Seed collection : The study involved *Bambusa tulda* Roxb. (Local name : Metinga bansh), *B. glaucescens* Siebold (Tetua bansh), *B. arundinacea* var. *spinosa* Roxb (Kanta bansh), *Oxytenanthera nigrociliata* Munro (Kali bansh) and *Dendrocalamus longispathus* Kurz (orah bansh, khag) All these species are thin-walled and growing naturally in the different forests of Bangladesh.

One clump of *B. glaucescens*, three clumps of *B. arundinacea* var. *spinosa*, and four clumps of *D. longispathus* flowered completely during April-July 1977, March-July 1978, and February-April 1979, respectively in the bambusetum of Bangladesh Forest Research Institute, Chittagong.

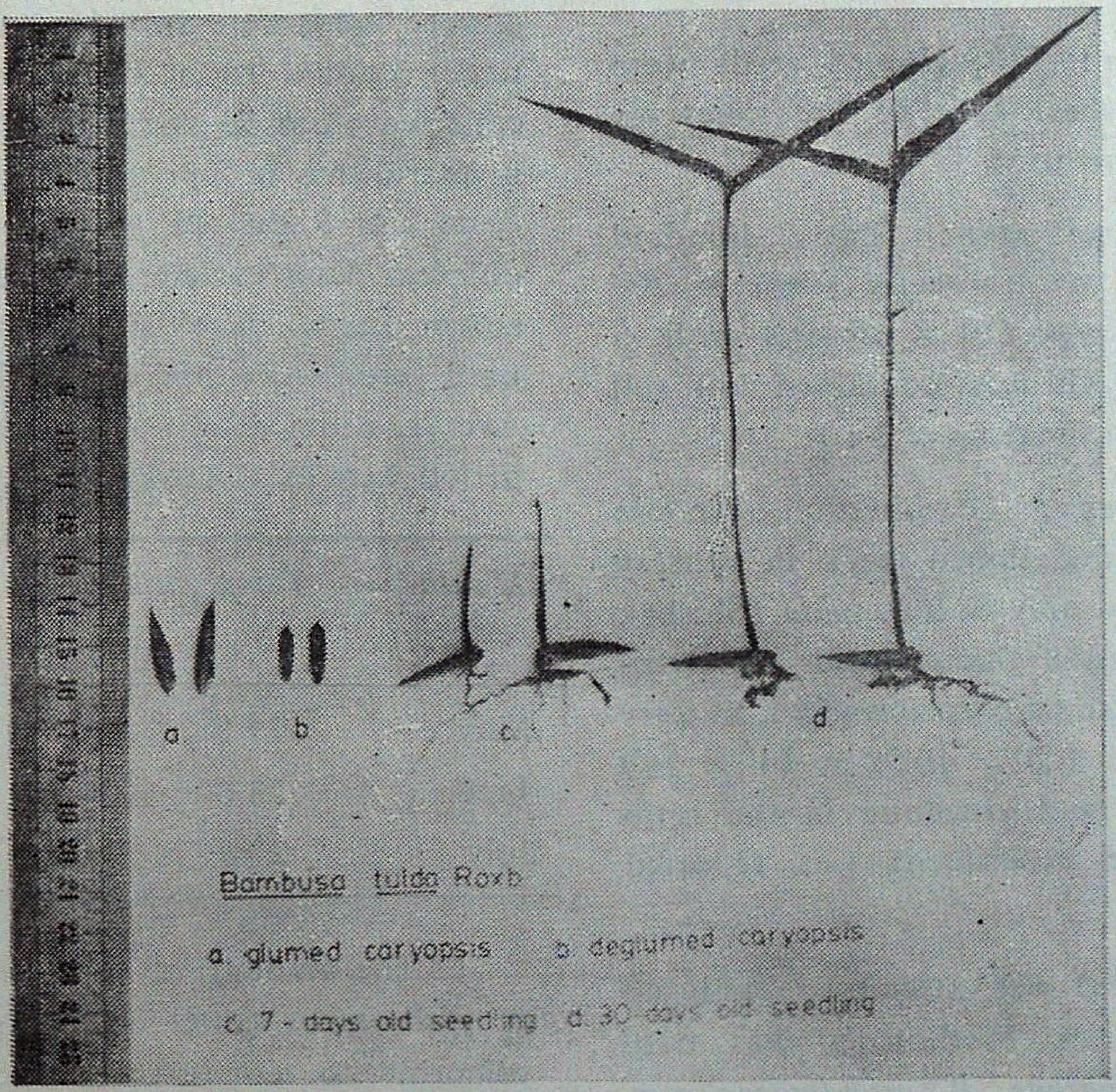
B. tulda flowered gregariously at three forest localities-Shishak in Chittagong Hill Tracts during May 1977, and Adampur and Lawachara in Sylhet during May 1978

and May 1979 respectively. Seeds were received from these sources about a week after harvest. As for *O. nigrociliata*, seeds were collected when a number of clumps flowered in Publakhali area in the Chittagong Hill Tracts during June 1978.

Measurement of glumed and deglumed 'seed' (caryopsis) : As the pericarp and the seed coat were fused, it was not possible to separate the seed from the fruit cover without any injury. However, the measurements were done only with glumed (covered with glume) and deglumed (glume removed) seeds (Fig. 1).

In both the *Bambusa* and *Oxytenanthera* species the shape of seed was linear—oblong with either acute or truncate tips, while in *D longispathus* it was more or less ovoid in nature and surmounted by a beak. The length, mid-width, mid-breadth of seeds of all the species were recorded except those of *D. longispathus* where only the diameter was measured due to their ovoidal and somewhat oblique shapes The number per 10 gm of seeds were also recorded in all the species. The measurements were repeated for a number of sampling Similar measurements were recorded only with the

Fig. 1



Seed and seedlings of *Bambusa tulda* Roxb.

glumed seeds of *O. nigrociliata* due to limited number of seeds.

Study was confined to the Shishak source of *B. tulda* because the seeds of all the three sources were identical in shape, size and look.

All the measurements were made within one week of receiving the seed samples.

Germination trials : At the begining, both glumed and deglumed seeds were sown on the moist blotting paper in petridishes. However, fungal infection occurred in deglumed seeds, and therefore glumed seeds of each species were used in the following methods of germination tests :

(a) *Petridishes* : Fifty glumed seeds were sown in petridishes. Most of the times six replications were used.

(b) *Polyethylene bags* : Two hundred glumed seeds were directly sown in 200 polyethylene bags (10 × 15 cm) with 3 replications. Each bag contained hill soil and cowdung in the ratio of 3 : 1.

(c) *Nursery beds :* Germination response from broadcasting glumed seeds in nursery beds was studied only with *B. tulda* (Shishak source). One kg of glumed seeds (approximately 14,000 fruits) were sown in a nursery bed measuring 1.20 × 10.98 m (4′ × 36′) containing soil and cowdung in the ratio of 3 : 1. The experiment was repeated thrice.

Method (a) was attempted with all the bamboo species. Method (b) was tried with *D. longispathus*, *B. arundinacea* var. *spinosa*, and *B. tulda* of all the sources. Method (c) was attempted only with *B. tulda* as sufficient amount of seeds were available from the Shishak source.

All the germination trials were made during the months of May to June. Experiments with method (a) were carried out in room temperature (Maximum 29.9°C, minimum 25.2°C) whereas other methods were tested under outside climatic condition at the central nursery of the Forest Research Institute. Average climatic conditions in the nursery at that time of the year were – maximum temperature 31.1 to 29.8°C, minimum temperature 22.8 to 23.4°C, relative humidity 64.7 to 68.6%, and total rainfall 27.8 to 80.0 cm.

Seed longevity : Immediately after collection, glumed seeds were stored in small jute bags under normal room conditions. From the collected stock 50 glumed seeds were sown in petridishes in four replications (in some cases 2 or 3 due to shortage of seed) on different dates to determine the life span of stored seeds. The study was continued until germination had ceased (May to July). Average room conditions during the study period were as follows :

Month	*Temperature, °C* Max.	Min.	*Relative humidity*, (%)
May	29.9	25.2	58.3
June	28.6	24.4	26.6
July	27.8	24.1	66.4

The amount of seed collected from *B. glaucescens* and *O. nigrociliata* was not sufficient to conduct the study on these species.

About 0.25 kg glumed seeds of

B. tulda were stored inside a desiccator containing Sorbisal Brand silica gel in room temperature. One hundred seeds were sown in petridishes for germination tests at the interval of 3 months. It was not possible to determine the moisture content of seeds due to limited number of seeds.

Results and Discussion

Glumed and deglumed seeds of *B. arundinacea* var. *spinosa* and *D. longispathus* were found to be smaller in size and lighter in weight than those of *B. tulda*. Seeds of *B. tulda* were heavier than others (Table 1).

In most cases germination started within 1 to 2 days of sowing and the mean germination percentage was significantly better in petridishes than in other methods (Table 2). Seed of *B. tulda* germinated poorly in the nursery bed, probably, because the seeds were washed away and buried deep in the soil due to heavy rainfall during that time (May-June) of the year. Adhering glumes on the seed created a condition for the broadcasted seed to float easily during heavy rainfall of May and June. With the polyethylene bag method this possibility was lesser and consequently the germination percentage was higher than in nursery bed (Table 2). In *B. tulda* the seeds from Adampur and Lawachara were found more fertile than those from Shishak source. Environmental factors during seed development might have a considerable effect on subsequent germination (Whittington, 1973). Geographically and environmentally Sylhet and Chittagong sources were different (Table 2). The modern concept of seed vigour is attributed to the physiological properties determined by the genotype and modified by the environment, which ultimately govern the ability of a seed to produce a seedling (Perry, 1972).

In all the bamboo species freshly collected seeds possessed excellent viability which resulted in good germination percentage in comparison to stored seed (Table 3). The total germination period (start to cease) was longer for fresh seeds than those for stored seeds. Similarly the germination percentage decreased with longer storage time. The life-span of seed varied from species to species. It was 30 to 35 days for *B tulda*, 55 days for *D. longispathus*, and 65 days for *B. arundinacea* var. *spinosa*. According to Kozlowski (1971), seed longevity controlled, most probably, by both environmental and genetic factors.

When the seeds of *B. tulda* were stored in a desiccator over silica gel the life-span increased upto 18 months (Table 4). Similar to jute bag storage, the germination period was also longer at the earlier period of seed storage in the desiccator. To increase the longevity of grass seeds Williams (1938) observed that excess moisture should be removed. Silica gel in a desiccator provides a drier climate by absorbing the seed moisture and thus increased the seed longevity of *B. tulda*. In the past it was also possible to preserve the seed viability of a bamboo species (*Phyllostachys* sp.) by storing the seed over calcium chloride (to remove moisture) at room temperature (White, 1947). Generally the two most important factors which govern seed longevity are the seed moisture content and the seed storage temperature (Harrington, 1972).

Conclusions

It is necessary to sow bamboo seed immediately after harvesting to obtain high

Table 1

Average size and weight of glumed seed (GS) and deglumed (DGS) of different bamboo species

Species	Length (cm)		Mid width (cm)		Mid breadth (cm)		Diameter (cm)	Number per 10 gms	
	GS	DGS	GS	DGS	GS	DGS	DGS	GS	DGS
B. tulda	2.49±0.05	1.49±0.02	0.35±0.006	0.31±0.005	0.28±0.006	0.22±0.004	—	139±1.1	168±2.4
B glaucescens	2.50±0.04	1.21±0.02	0.31±0.005	0.25±0.005	0.27±0.004	0.17±0.004	—	151±2.5	180±1.8
B. arundinaceae var. *spinosa*	0.83±0.007	0.56±0.003	0.19±0.003	0.19±0.003	0.17±0.006	0.13±0.003	—	1320±7.0	1664±6.2
D. longispathus	—	—	—	—	—	—	0.19±0.004	—	1351±2.2
O. nigrociliata	1.91±0.04	—	0.29±0.007	—	0.21±0 004	—	—	265±1.1	—

Table 2

Germination period (start to cease) and germination percentage of glumed seed of some species of bamboo tested under three different methods

Species	(a) Petridish Germination					(b) Polyethylene bag Germination					(c) Nursery bed Germination				
	Seed sown (Nos)	Period (days)			% (Avg.)	Seed sown (Nos)	Period (days)			% (Avg.)	Seed sown (Nos)	Period (days)			% (Avg.)
		Start	Cease	Total			Start	Cease	Total			Start	Cease	Total	
B. glaucescens	300	1	3	3	40.2	—	—	—	—	—	—	—	—	—	—
B. arundinacea var. *spinosa*	300	5	14	10	52.3	600	10	33	24	23.6	—	—	—	—	—
D. longispathus	300	2	9	8	50.0	600	7	25	19	33.4	—	—	—	—	—
O. nigrociliata	100	1	9	9	39.0	—	—	—	—	—	—	—	—	—	—
*B. tulda**	300	1	3	3	26.4	600	5	20	16	24.7	14000	7	25	19	5.5
*B. tulda***	300	1	4	4	40.6	600	6	20	15	30.7	—	—	—	—	—
*B. tulda****	300	1	4	4	48.0	—	—	—	—	—	—	—	—	—	—

* Seed from Shishak of Chittagong Hill Tracts Forest (Average total annual rainfall 250-280 cm, maximum temp. 31.3°C, minimum temp. 21.8°C, more than 180 m above the sea level, longitude 92°21′ E, latitude 22°38′ N).

** and *** Seed from Adampur and Lawachara of Sylhet Forest respectively having more or less similar climatic conditions. (Avg. total annual rainfall 280-381 cm, maximum temp. 30.5°C, minimum temp. 18.9°C, 23 m above the sea level, longitude 91°44′ E, latitude 24°12′ N).

Table 3

Seed longevity for some bamboo species at different time intervals after collection. Seed were stored in small jute bags under normal room condition.

Time between collection and sowing (days)	*Bambusa tulda**				*B. tulda****				*D. longispathus*				*B. arundinacea* var. *spinosa*			
	Germination				Germination				Germination				Germination			
	Period (days)			% (Avg)	Period (days)			% (Avg.)	Period (days)			% (Avg.)	(Period days)			% (Avg.)
	Start	Cease	Total		Start	Cease	Total		Start	Cease	Total		Start	Ceas	Total	
3	—	—	—	—	—	—	—	—	2	9	8	51.1	5	14	10	49.5
10	1	3	3	26.4	2	5	4	48.0	2	7	6	42.2	5	12	8	29.3
20	1	3	3	8.0	2	4	3	30.0	1	5	5	28 8	5	10	6	35.0
25	2	2	1	5.0	2	3	2	23.0	—	—	—	—	—	—	—	—
30	1	1	1	2.0	2	3	2	7.0	3	7	5	17.7	4	10	7	34.0
35	0	0	0	0	3	3	1	2.0	—	—	—	—	3	8	6	31.0
40	0	0	0	0	0	0	0	0	2	8	5	15.5	2	8	7	35.0
45	0	0	0	0	0	0	0	0	2	6	5	13.3	2	7	6	27.0
50	0	0	0	0	0	0	0	0	2	4	3	8.8	4	7	4	13.0
55	0	0	0	0	0	0	0	0	2	2	1	2.1	3	7	5	8 0
60	0	0	0	0	0	0	0	0	0	0	0	0	3	7	5	5.0
65	0	0	0	0	0	0	0	0	0	0	0	0	6	6	1	2.0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* Shishak source *** Lawachara source, seed were received after a week of harvest.

Table 4

Seed longevity of Bambusa tulda when stored over silica gel inside a desiccator.

Time between collection and sown (month)	Germination period (days)			Germination (%)
	Start	Cease	Total	
3	9	14	6	11
6	8	12	5	7
9	9	12	4	8
12	10	11	2	5
15	11	11	1	3
18	11	11	1	2
21	0	0	0	0

germination percentages. Generally, seed longevity varies from one to two months only. However, it can be increased upto 18 months by storing over silica gel inside a desiccator. It is very necessary to conduct a methodical experiment on the effects of lowering the temperature, relative humidity and seed moisture on the longevity of bamboo seed to determine suitable methods of seed preservation.

Success of germination is better in petridishes and polyethylene bags than in nursery beds. However, for large scale plantation the polyethylene bag method is more practicable.

SUMMARY

Size and weight of both glumed and deglumed seeds of five different bamboo species of Bangladesh were measured and their shape noted. Seed germination and longevity were also studied. It was found that the fresh seeds germinated better then stored ones. The seed longevity period varied among the species from one to two months and could be increased upto 18 months when seeds were stored over silica gel in a desiccator.

कतिपय बांस जातियों में बीज अंकुरण

रतनलाल बनिक

सारांश

बंगला देश की पांच विभिन्न बांस जातियों के बुसपत्र लगे और बुसपत्र निकाले दोनों तरह के बीजों का आकार और भार मापा गया तथा उनकी आकृति को लिखा गया। बीजांकुरण और जीवन शक्ति काल का अध्ययन किया गया। देखा यह गया कि भंडार म रखे बीजों की तुलना में ताजे बीज अच्छे जमते हैं। बीजों का जीवन-काल विभिन्न जातियों में भिन्न, एक से दो मास तक का रहा जिसे डेसिकेटर (शोष्यक) में सिलिका जैल लगाकर रखने पर 18 मास तक बढ़ाया जा सकता है।

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CORRIGENDUM

In Research Note (III) "*Julodis* sp. (Coleoptera : Buprestidae) A new record on Israeli Babool (*Acacia totalis* from North-West part of Rajasthan" by Harish Chandra published in the *Indian Forester*, Vol. 113, No. 6, June, 1987, Page 454—For *Acacia totalis* read *Acacia tortalis.*

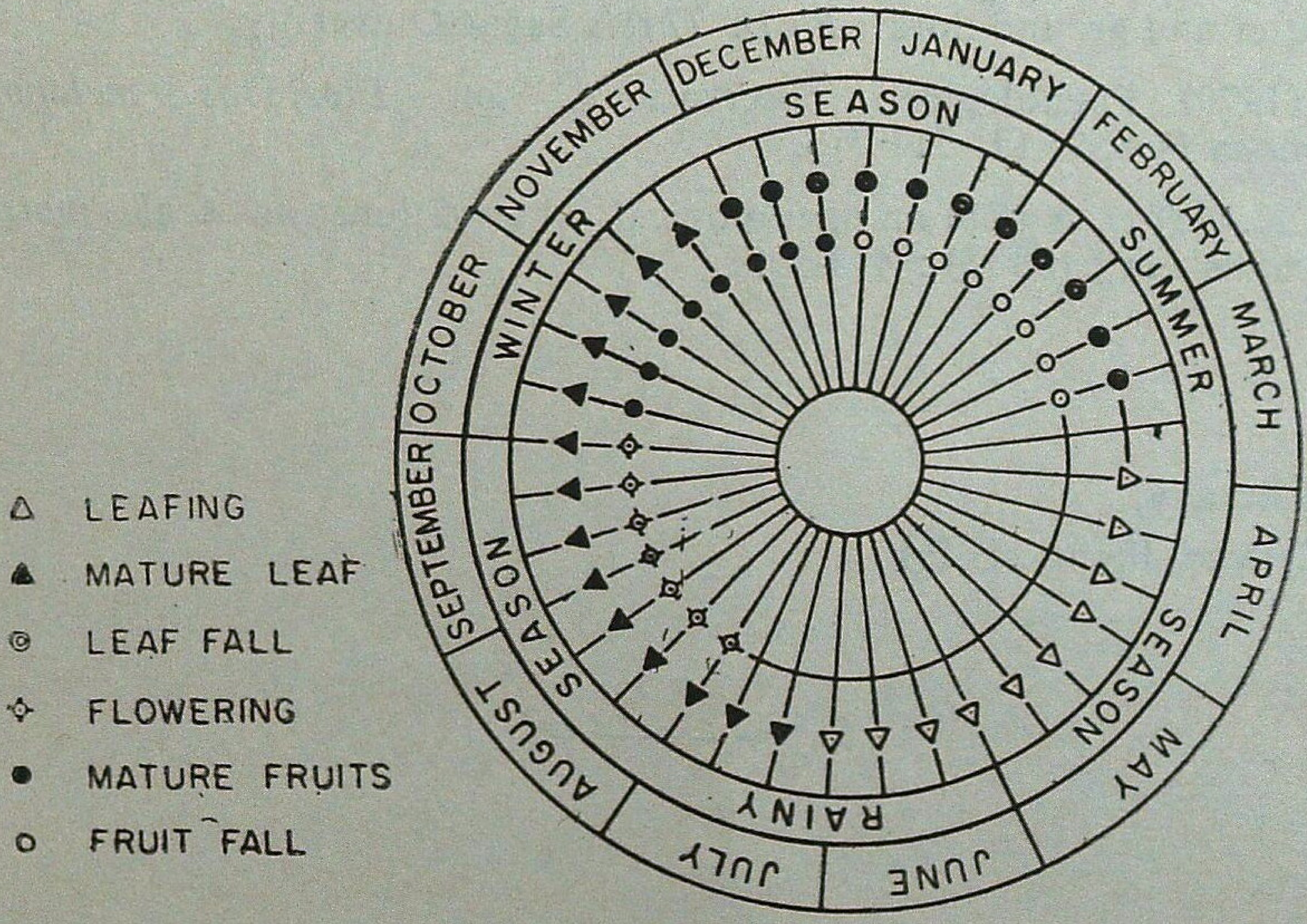
RESEARCH NOTE

A NOTE ON PHENOLOGICAL OBSERVATIONS ON *ANOGEISSUS PENDULA* EDGEW.

Vegetative and reproductive responses of different tree species vary considerably from year to year. It is becoming increasingly important that agencies working with forests should fully understand the seasonal behaviour of trees with which they work as this phenomenon may be of practical utility in relation to various aspect. Bhatnagar (1968) divided the forest species of Sagar district (M P) into three categories on the basis of their different phenological behaviour namely (i) with foliation and flowering periods discontinuous (ii) with flowering and foliation continuous and (iii) with flowering over-lapping foliation.

Anogeissus pendula is one of the most dominant as well as an important forest tree species of Bundelkhand region. The work on this valuable tree species is still very scanty. The phenological events of this species have been summarised in the present communication and they have been expressed by a phenobiogram (Fig. 1) separately. Rathore (1970) and Srivastava (1982) have also expressed the phenological events of *Diospyros melanoxylon* and *Aegle marmelos* in term of their phenobiogram respectively.

Fig. 1



Phenobiogram of *Anogeissus pendula*

The phenological events of *A. pendula* in relation to different seasons has been observed as under.

Leafing: The initiation of new leaves starts in the beginning of April. Early, young leaves were small, pinkish-yellow, possessing silky hairs on both the surfaces. With the enlargement of size of leaves the number of hairs gets reduced and the colour of leaves also changed to green. The initiation period continues till the end of June after which the leaves attain their full size. During the month of October the colour of leaves (about 10% of total) changed to dull reddish brown.

Leaf-fall: The leaf-fall of this species started in Winter season in the beginning of December and by the end of January about 60% leaves were shed. The tree became leaf-less in the second week of March and remained as such for a very short period (till beginning of April).

Flowering : In *A. pendula* the flowering initiated in the month of August and completed till the end of September.

Fruit-fall : The fruit-fall of this species started in January and completed till the end of February. In rare cases the fruits may remain attached to their trees in March too but the percentage of such trees as well as seeds is very negligible (about 1%).

Acknowledgement

I wish to express my thanks to Dr. S.P. Bajpai, Reader, Department of Botany, Dr. Hari Singh Gour Vishwa Vidyalaya, Sagar for his guidance.

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Department of Botany,
Bipin Bihari College, Jhansi (U.P.)

J.P. Tripathi

LETTER TO THE EDITOR

To,

The Honorary Editor,
Indian Forester,
P.O. New Forest
Dehra Dun. U. P.

Dear Sir,

During hundred years of Forestry, Extension activities have continued to take a back seat. Even in recent past, an approved proposal for setting up of "Vava Vigyan Kendras" was shelved for reasons unknown. Such centres would have helped in Lab-to-field efforts of useful scientific and technological data.

The social forestry wings of the State Forest Departments during the last decade have moved in and during a short period have done an excellent job in reaching the people. A time has now come for introduction of professionalism in extension service. Recently in my visits to rural areas I was asked by farmers about height and diameter growths of plants encouraged by local Forest Deptts.

Such basic information as well as information on value growth and facilities for marketing should be made readily available to encourage tree farming.

I request you to kindly pass on this message to the serving forest officers.

Thanking you,

Yours faithfully

Sd./- D.K. Ganguly
M.Sc. AIFC, IFS (Retd.)
Chief Conservator of Forest &
Ex-Officio Secretary (Forest) W.B.

DB 98, Sector-1
Salt Lake City
Calcutta 700064

July. 17th 1987

GAZETTE NOTIFICATIONS

F.R.I. GAZETTE

The President Forest Research Institute and Colleges, Dehra Dun has been pleased to appoint following Research Assistant Grade-I (SG)/Research Assistant Grade-I as Research Officer in the scale of Rs. 2000-3500 in a temporary capacity with effect from the dates mentioned against each until further orders :

1.	Shri Syed Muzaffar Hussain	— 28.5 87 (A.N.)
2.	Shri J B. Singh	— 28 5.87 (A.N.)
3.	Shri J.K Jain	— 28 5.87 (A.N.)
4.	Mrs. Uma Singh	— 28.5.87 (A N.)
5.	Dr. B.G. Karira	— 28.5.87 (A.N.)
6.	Shri S.C. Pant	— 01.6 87 (F.N.)
7.	Shri N K. Jain	— 05.6.87 (F N.)
8.	Shri M.P. Dimri	– 28.5.87 (A.N.)
9.	Shri R.C. Saxena	— 28.5.87 (A.N.)

KARNATAKA GAZETTE

On repatriation from Govt. of India Shri M.L. Ramaprakash, IFS, Conservator of Forests is appointed with immediate effect and until further orders as Conservator of Forests, (Head Quarters) in the Office of the Chief Conservator of Forests (General) Bangalore vice Shri B.K. Gowda, IFS, transferred.

Shri B.K. Gowda, IFS, Conservator of Forests, (Head Quarters) in the Office of the Chief Conservator of Forests (General) is appointed with immediate effect and until further orders as Conservator of Forests, Bangalore Circle, Bangalore vice Shri N. Sampangi, IFS, transferred.

Shri N. Sampangi, IFS, Conservator of Forests, Bangalore Circle, Bangalore is appointed with immediate effect and until further orders as Conservator of Forests, Social Forestry, Research, Extension and Training and T.A. to CCF (Dev.) Bangalore vice Shri A.S. Kumar, IFS, transferred.

Shri A.S Kumar, IFS, Conservator of Forests, Social Forestry, Research and Training and T.A to CCF (Dev.) Bangalore is appointed with immediate effect and until further orders as Conservator of Forests, Bellary Circle, Bellary, vice Shri Bhaskar, IFS, deputed to Govt. of India.

Shri R.M. Ray, Deputy Conservator of Forests, Yellapur Div., Yellapur is promoted to officiate in the Supertime Scale of Indian Forest Service viz., Rs. 4500-150-5700 and his services are placed at the disposal of Animal Husbandry, Fisheries and Forests Dept. for appointment as Conservator of Forests, Karnataka Forest Plantation Corporation Ltd., Bangalore against a newly created post.

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OBITUARY

C.R. Ranganathan

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Mr. C.R. Ranganathan, former Inspector General of Forests, Govt. of India, passed away on 9th July 1987 at Bangalore. He was 88.

After a brilliant academic career, securing first rank in M.A. Chemistry from the Madras University, Mr. Ranganathan joined the Indian Forest Service in 1921. As a probationer he was sent to Exeter College of the University of Oxford, U.K. for the forestry course. He passed M.A. Forestry standing first among the Indian Forest Service Officers of his batch from the Oxford, Cambridge & Edinburgh Universities and was awarded the Currie Prize.

Mr. Ranganathan opted for the Madras Cadre and his career in the old Madras Presidency was particularly notable for the working plans he prepared which still remain as standard works of reference. His working plan for Coimbatore North Division is a masterly treatise on the Silviculture and management of Sandal (*Santalum album*). During the preparation of the working plan for the Nilgiris division he made a detailed study of the ecology of Shola-grassland vegetation of the Nilgiri hills. Later he wrote a paper on the subject and for this he was awarded the Schlich prize.

The job which was most dear to Mr. Ranganathan was, however, as a teacher. He was the first Indian Director of the Indian Forest Rangers' College, Dehra Dun and he held this post from 1938 to 1945. He reverted to Madras State in 1945 to restart the Madras Forest College at Coimbatore which he headed for two years. His erudition, grasp and knowledge of the subject and faultless diction made him a great teacher. His concern for his students extended well beyond the years he taught them and in turn their affection and regard for their teacher remained undiminished long after their student days. Subsequently, he was promoted as the Director of Forest Education, Govt. of India and again he was the first Indian to hold this post.

(*Contd...*)

Mr. Ranganathan was promoted as the Chief Conservator of Forests, Madras State in 1947 but he opted to serve in the Govt. of India as the President, Forest Research Institute, Dehra Dun, which post he held with distinction till 1954. He was selected as the Inspector General of Forests, Govt. of India, in 1954 and retired from the Indian Forest Service in 1957.

After retirement Mr. Ranganathan joined the Fertilizer Association of India as the Executive Director and during his tenure of 15 years he built up the organisation from scratch.

Mr. Ranganathan's forestry career which spanned 36 years covered diverse fields and in each he left his stamp of greatness. Those who were privileged to work with him remember him as a man of dignity, integrity and warmth who did his duty with a sense of justice and fair play. He was respected and admired for his intellectual eminence, uncompromising principles and high standard of conduct. He was a forester of international repute and was elected as an Honorary Member of the Society of American Foresters, the German Academy of Agricultural Sciences and the Finnish Forestry Association.

Mr. & Mrs. Ranganathan were generous hosts with a wide circle of friends and even a junior probationer was welcome in their home. Modest and unassuming, Mr. Ranganathan preferred to listen more than talk but few could fail to be impressed by his dignity, grace and erudition.

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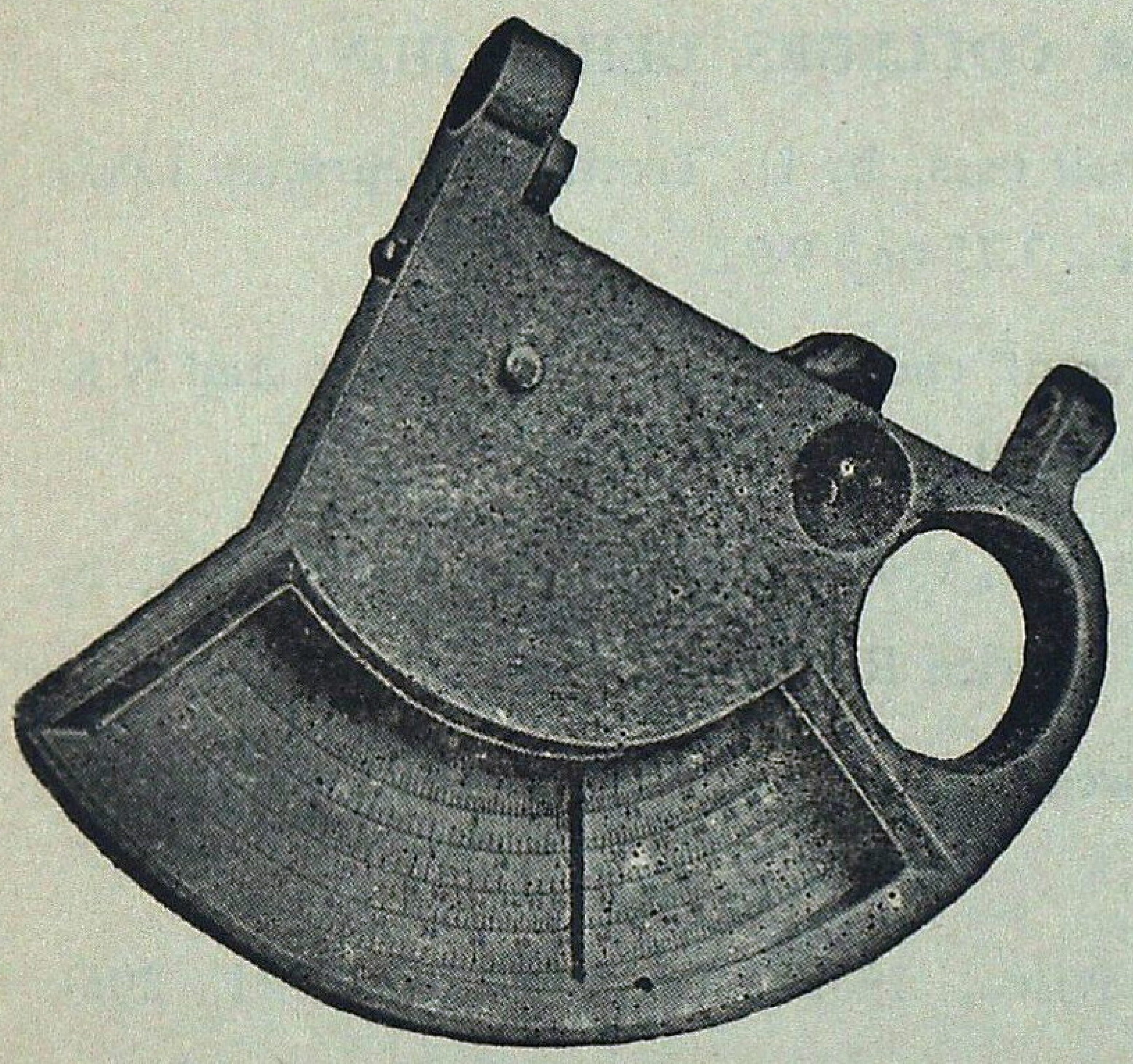

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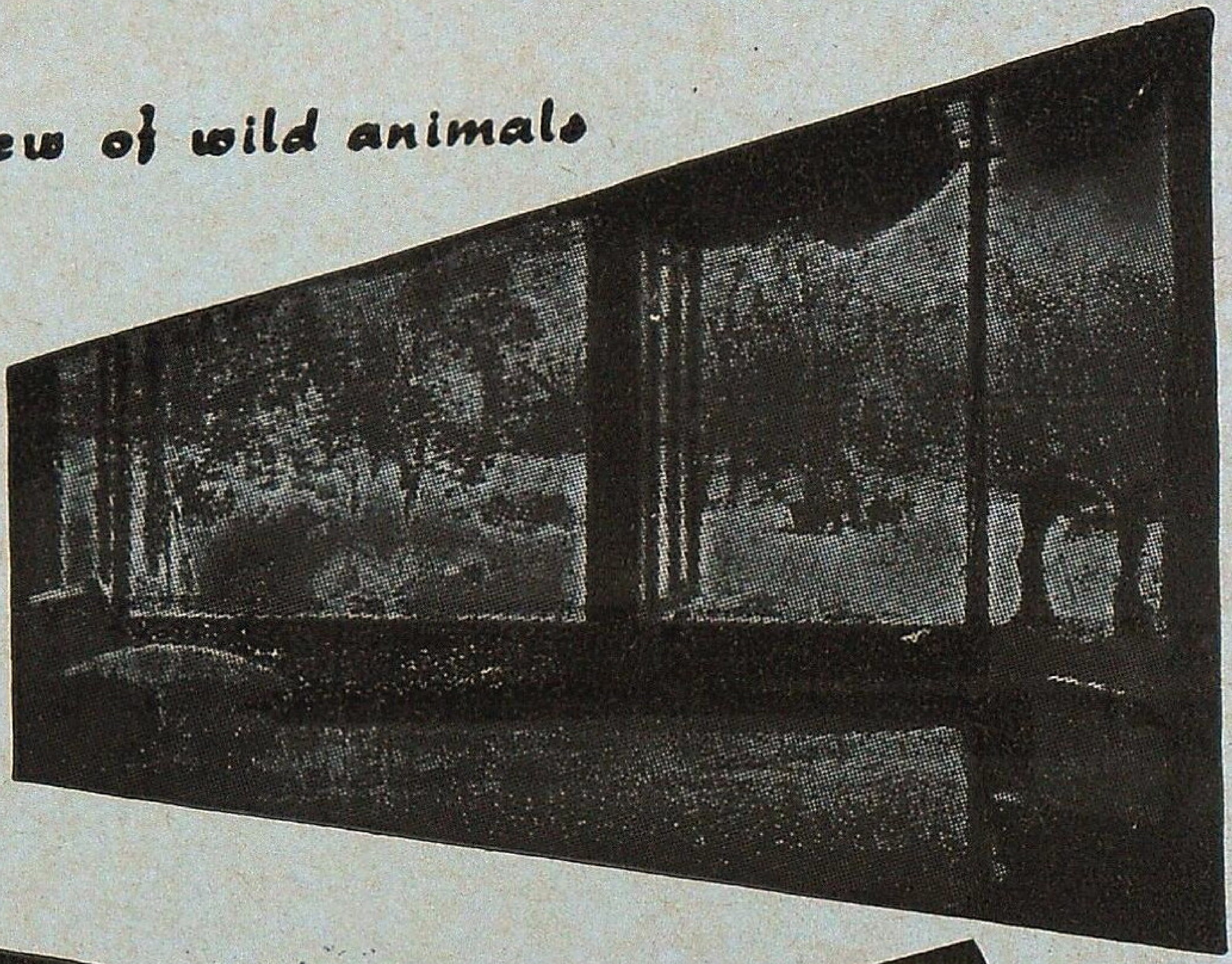

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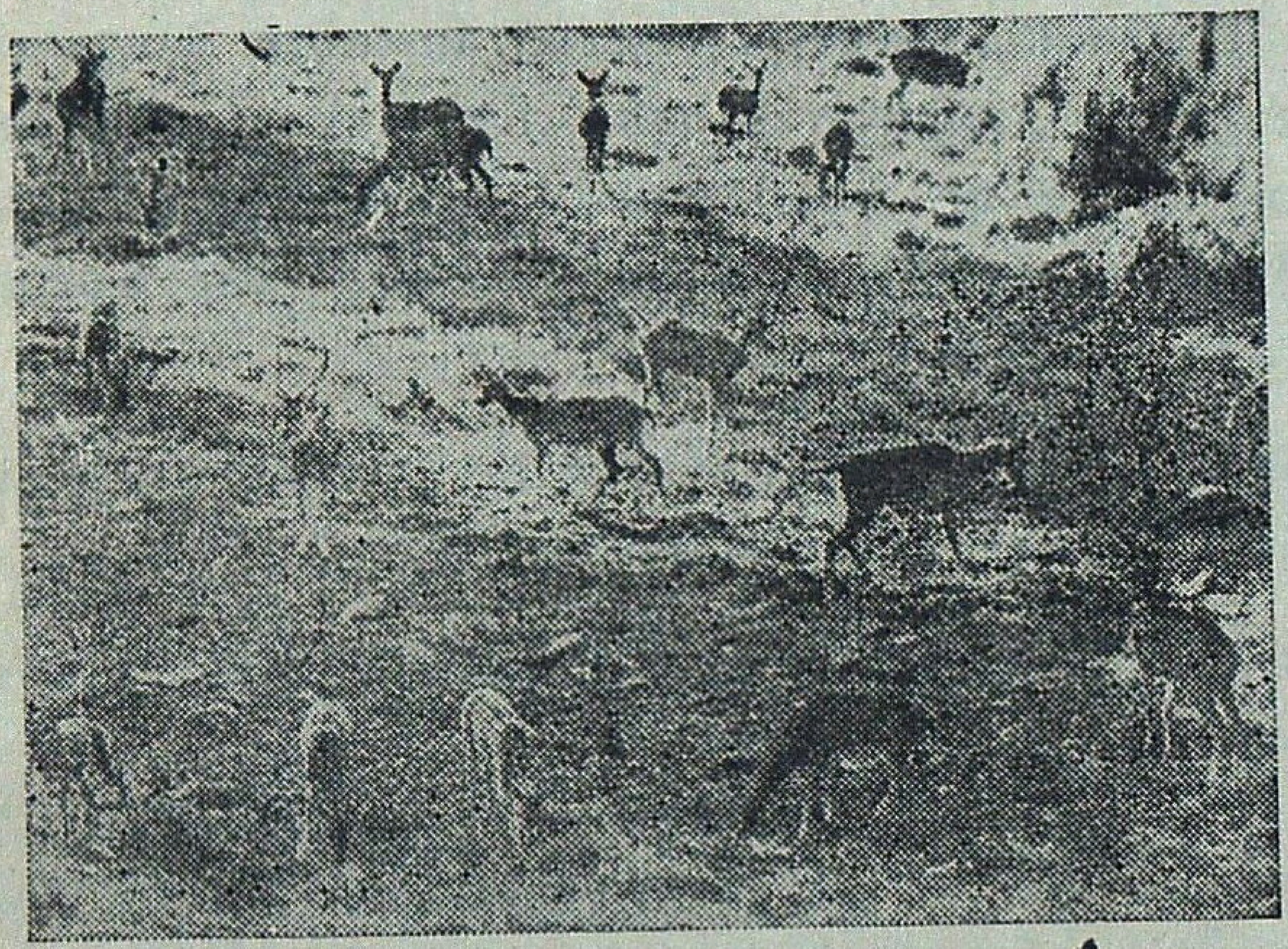

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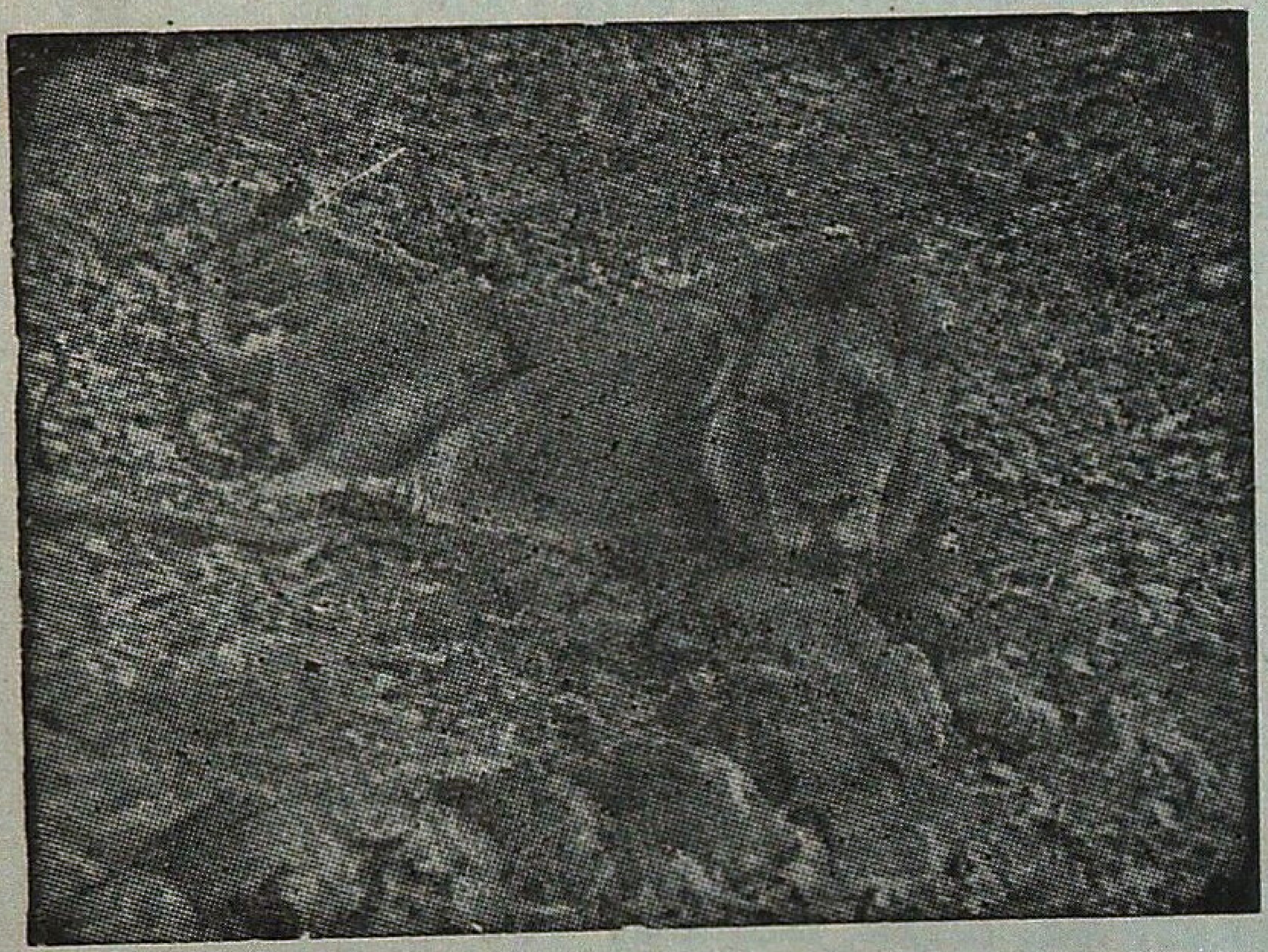

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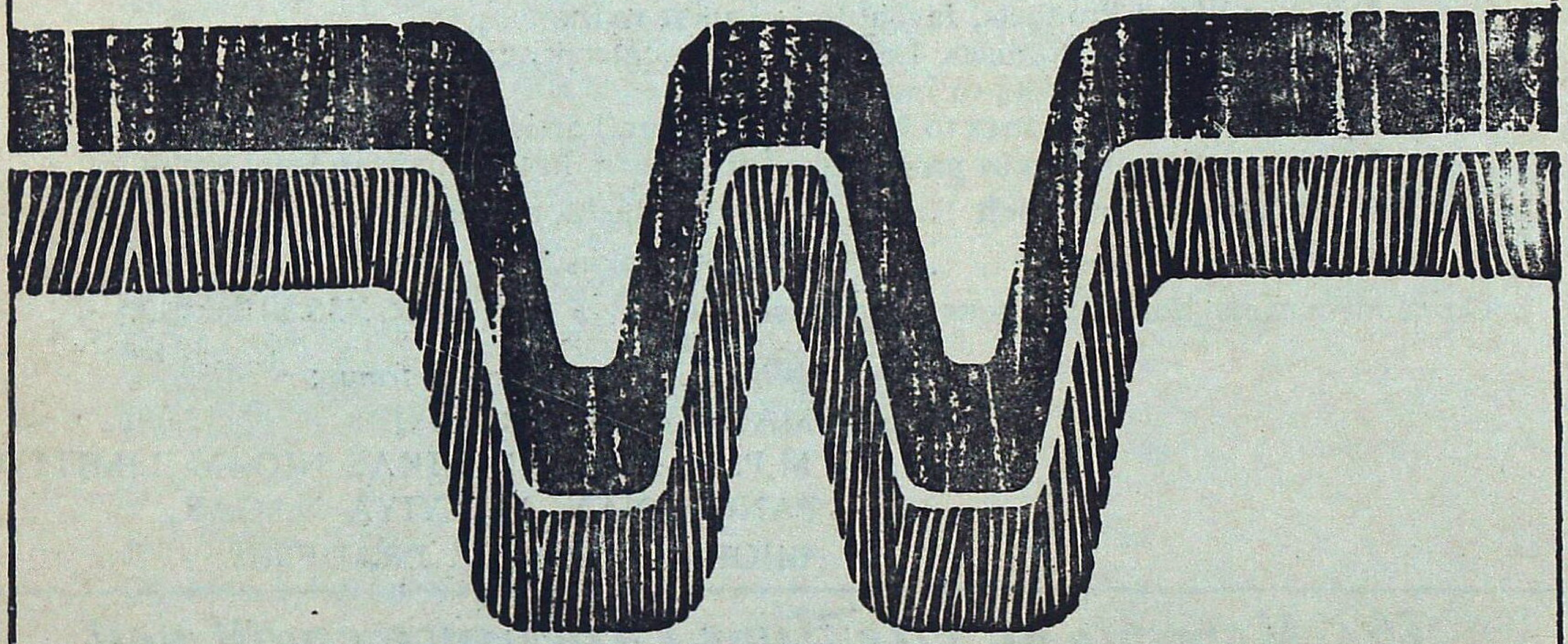

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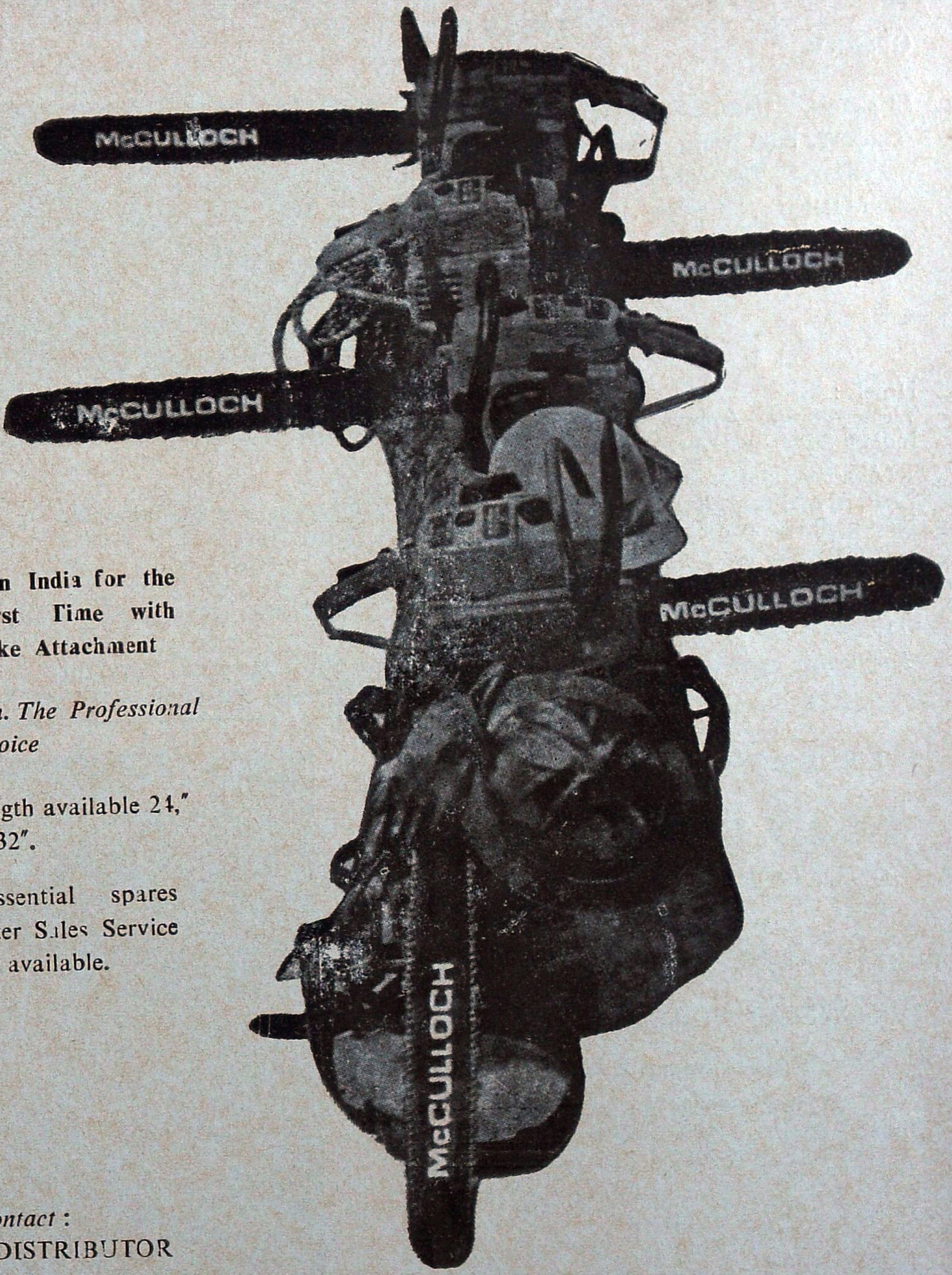

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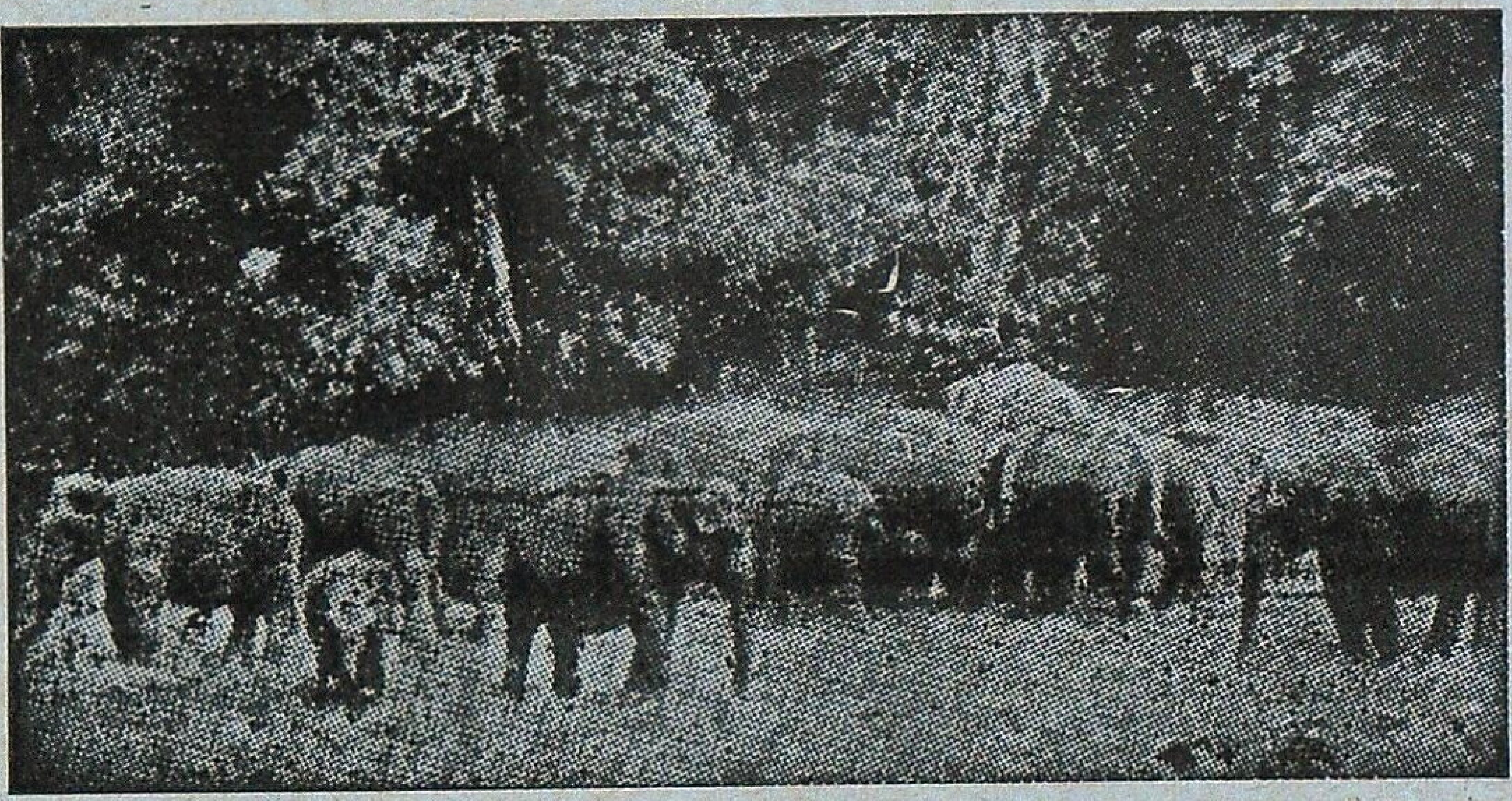

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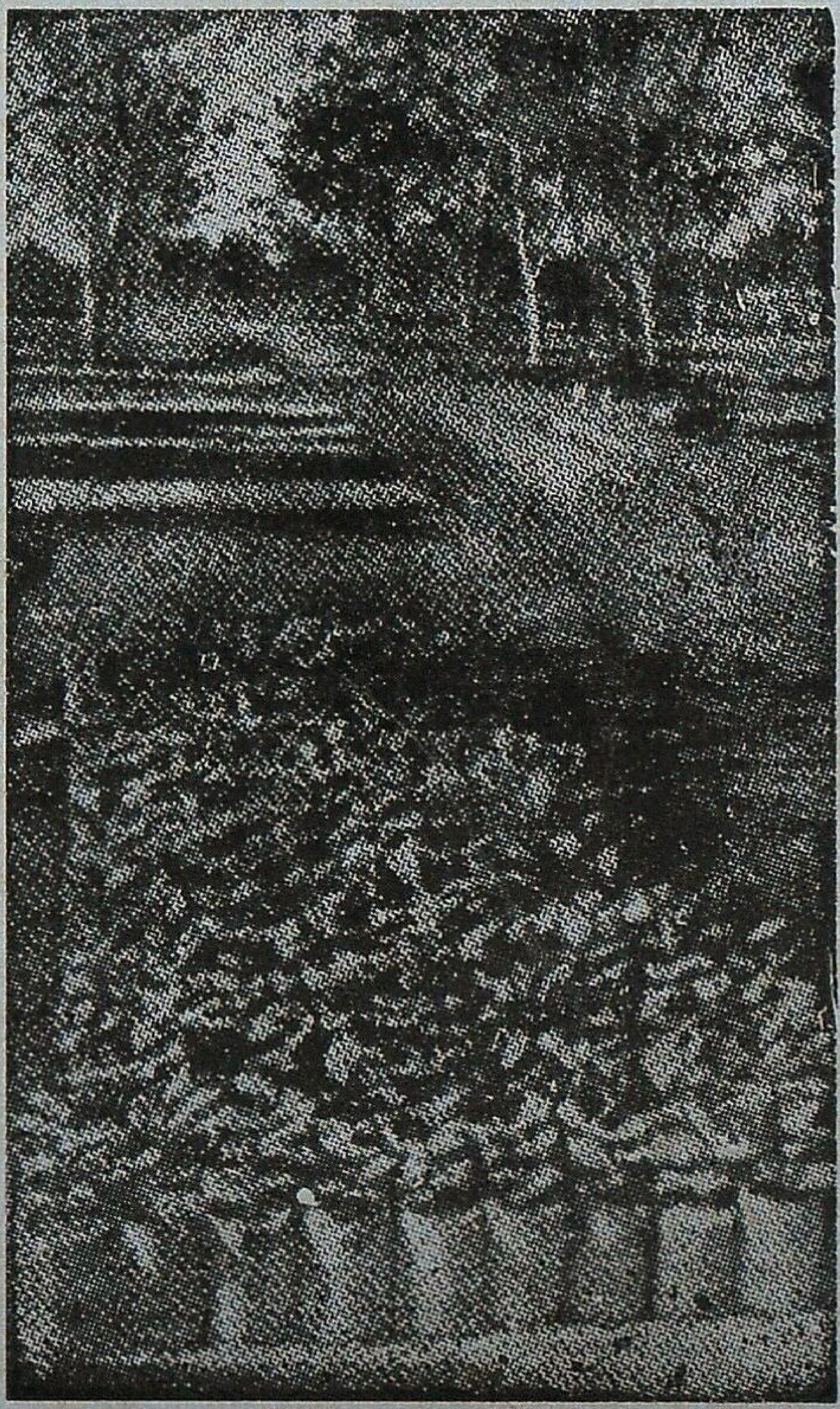

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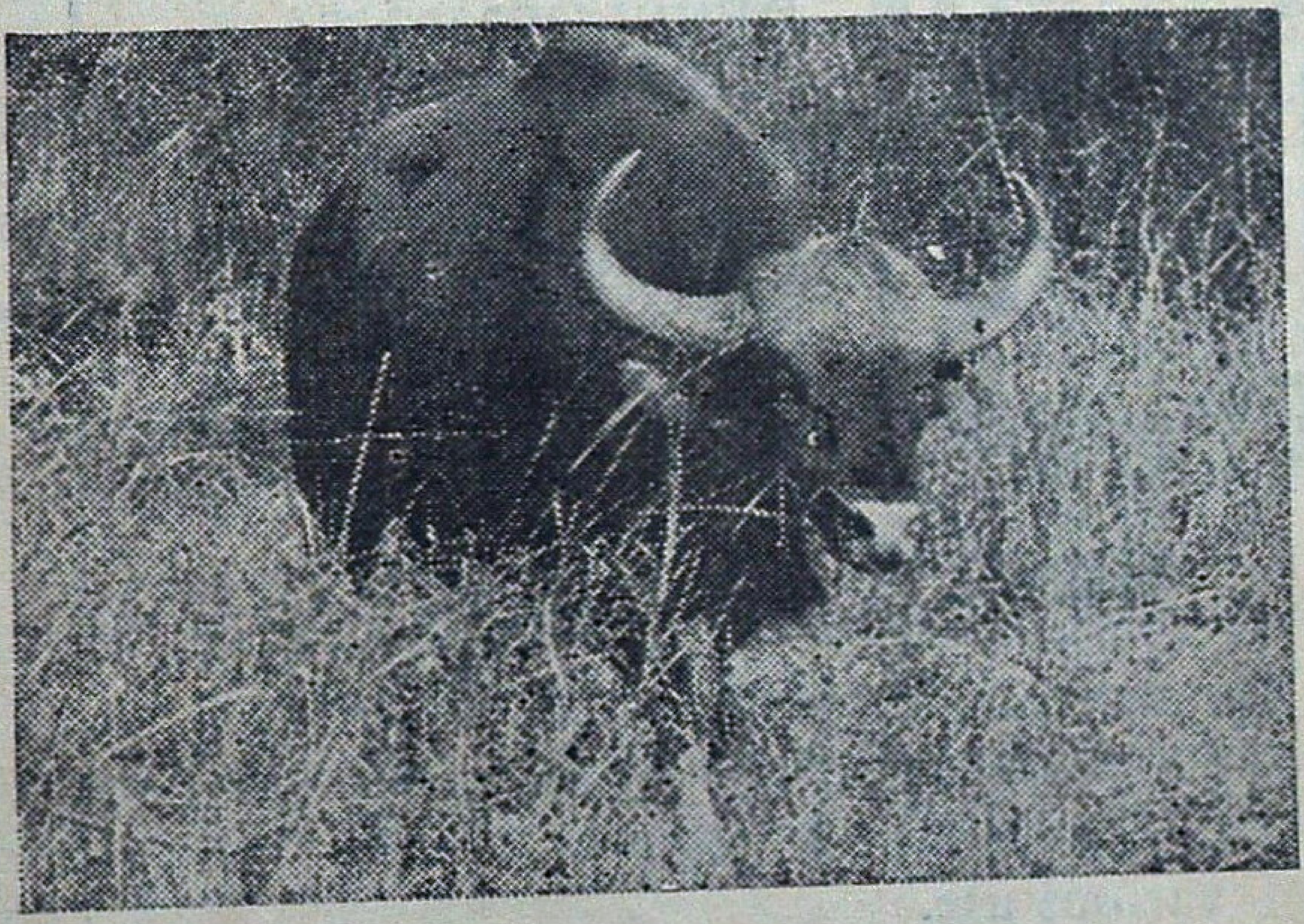

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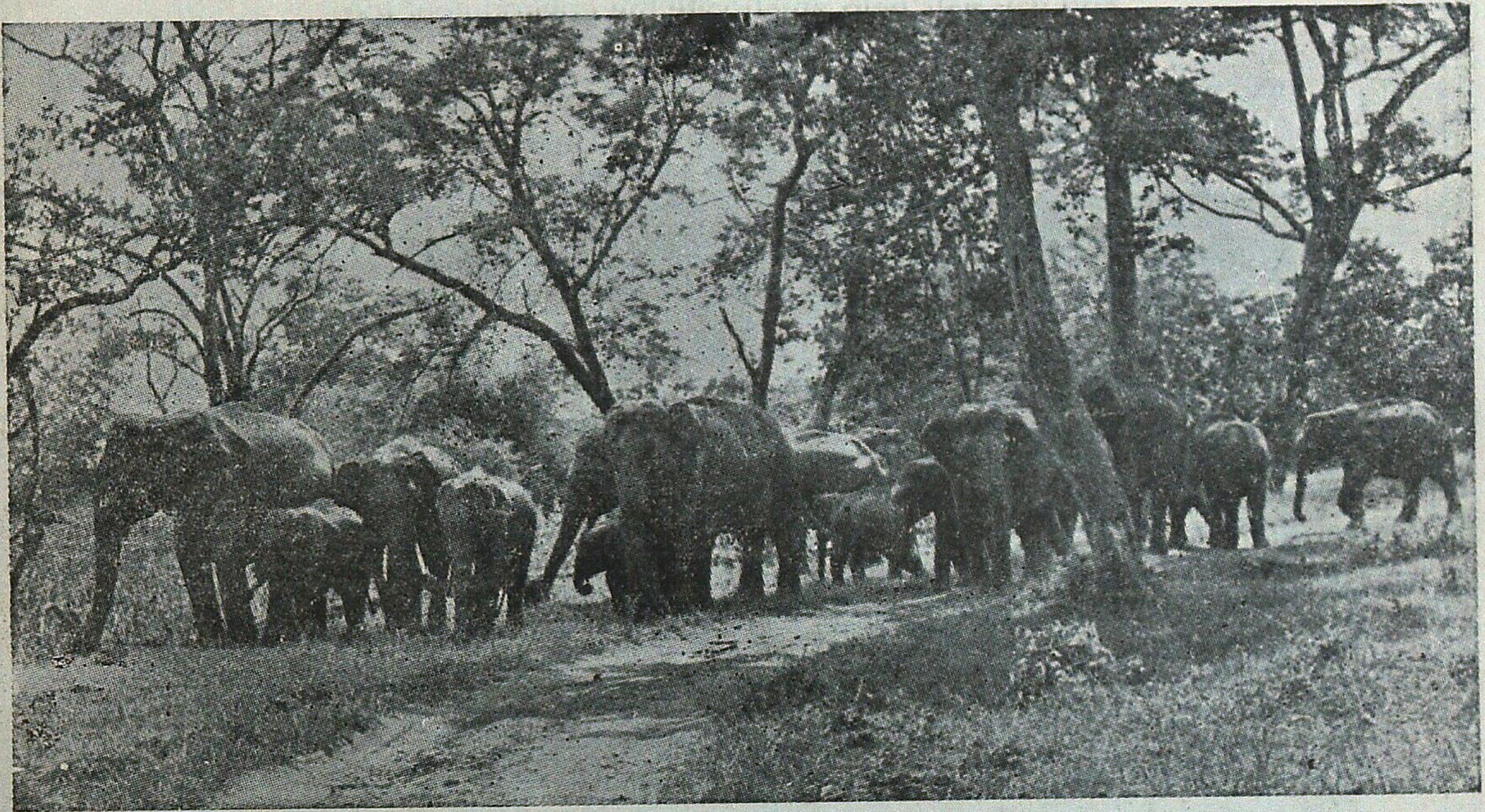

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Himachal Pradesh State Forest Corporation Ltd.

(A Govt. of Himachal Pradesh Undertaking)

HPFSC marches ahead towards a better tomorrow under the dynamic guidance and leadership of Hon'ble Chief Minister Shri Vir Bhadra Singh.

Himachal Pradesh State Forest Corporation has taken long strides under the benevolent guidance of our Chairman Prof. Chander Kumar, Hon'ble Minister of State for Forests.

* With complete nationalisation of forest working viz; timber operations, resin tapping etc. both in Govt. and private forests, there is complete elimination of contractor' agency. Modernisation of timber operations has reduced conversion wastage considerably and the incidence of organized illicit felling in forests is completely under control.

* To ensure gradual reduction in use of valuable coniferous timber for packing cases, effective steps have been taken for distribution of Card Board Cartons and purchase of Wooden Packing Cases from adjoining States of Punjab and Haryana.

* Stocks of timber extracted by Corporation are being supplied towards developmental works by catering to the requirements of Indian Railways, Director General of Supplies and Disposals, Defence Organisation and other Govt. Indenters. Sale of timber stocks is being organized through well established sale depots conveniently located.

* The annual turn-over has registered a significant increase from its inception from 1974-75 being Rs. 2.43 crores to Rs. 44.83 crores in 1986-87.

* In order to maximize operational efficiency, following steps have now been initiated :

a) Replacement of old fleet of trucks for minimising transportatton time of timber to depots;

b) Analysis of financial data through computer net-work to ensure prompt and efficient working.

c) Providing incentives to officers and staff through prompt action on service matters like confirmations, job rotation vis-to-vis career planning including specialized training.

(V.P. Mohan)
Managing Director.

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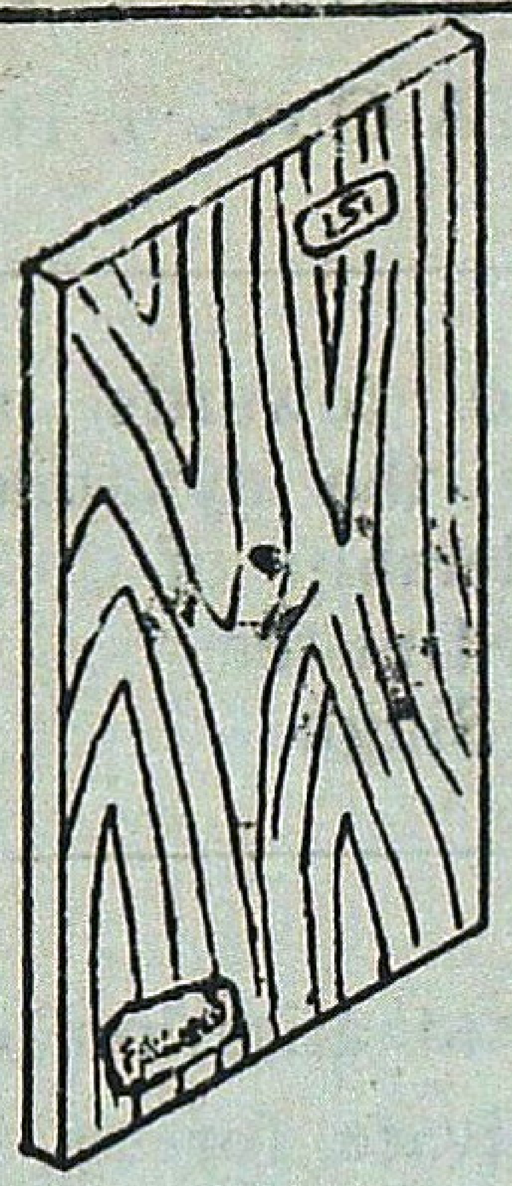

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Bhagirathi Catchment – A view from Gangnani.
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